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Recreations in Science;

OR,

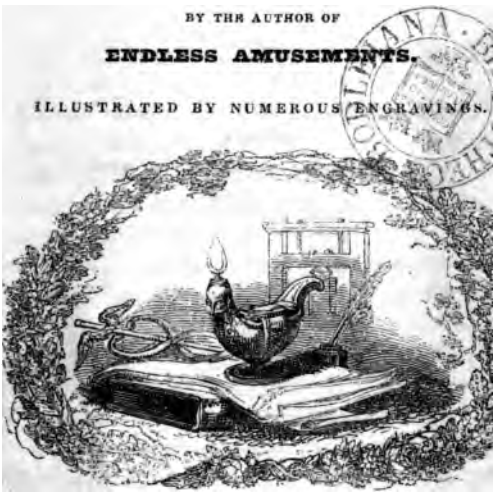
A COMPLETE SERIES OF

RATIONAL AMUSEMENT

BY THE AUTHOR OF

ENDLESS AMUSEMENTS.

ILLUSTRATED BY NUMEROUS ENGRAVINGS.



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PREFACE.

A COLLECTION of curious facts in Nature and Art, whether discovered by accident, or the result of philosophical investigation, has always been deemed information of the highest value and importance; an acquaintance with facts constitutes useful knowledge, since they never can mislead, however systems and treatises founded upon them may differ in their conclusions. Without being acquainted with the materials from whence theories are constructed, we may be imposed upon by the misconceptions of others, and the results of our studies will then be unproductive of solid benefit. The importance of drawing conclusions from observations on facts has long been universally admitted; and acted upon, in the adoption of the Baconian, and the rejection of the Aristotelian methods, of investigating nature.

Numerous phenomena are from time to time discovered, many *of which* are regarded for centuries

merely as matter of curiosity or entertainment, because no practical application of their nature has been invented or thought of. Thus it was with the loadstone, with which the ancients were acquainted; the extraordinary property it possesses of attracting iron, naturally excited their astonishment and delight, but it was reserved for their descendants in after ages to render it subservient, in the mariner's compass, to traverse the trackless ocean. At the present time, the discovery of the expansive force of the liquifiable gases is generally regarded as of little utility, but it is not improbable that, centuries hence, our posterity will discover means to manage, control, and exercise the vast powers of these gases, as easily as we now do that of steam, of which the ancients were ignorant. Many other discoveries recorded in the pages of this volume, apparently of trivial importance, may hereafter be rendered subservient to the uses of man.

This work is, however, by no means confined to the explanation or relation of isolated facts; it contains, within its convenient bulk, several hundred experiments and processes in the useful arts, a large portion of which are easily practised without any previous acquaintance with the subjects to which they relate, and many of them consist in valuable improvements in domestic economy.

The experiments are also generally calculated to

give the reader an insight into the various sciences, of which they form so many interesting illustrations, (especially Chemistry, Hydraulics, Hydrostatics, Pneumatics,) and incite him to a prosecution of those studies, which will afford him lasting enjoyment and profit.

A slight inspection of the volume will convince the reader, that the object of the writer has been to condense a great fund of information, of the most pleasing and valuable kind, into the smallest space, so as to render it conveniently accessible. The eminent success which has attended a former work, executed by the same hands, entitled "A SEQUEL TO ENDLESS AMUSEMENT," is an earnest to the public, that the present volume, which contains the most recent discoveries in science and art, will meet with an equally flattering reception.

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Fig.1.
A
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Fig 2.
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Fig 3
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Fig.
A

RECREATIONS

IN

SCIENCE.

The Automaton Chess Player.

THE automaton chess-player of Kempelen was introduced into England by its inventor in 1783, and has recently been exhibited in various parts of England and Scotland. The interest which it excited is still unallayed; and the public opinion is pretty equally divided between the two theories, of its being a piece of real machinery, directed by the exhibitor, or a piece of ingenious deception, under the control of an internal agent. If the impossibility of a chess-player being concealed in the machine had been thoroughly established, there would have been no hesitation in considering magnetism as the moving power; but a very narrow inspection of the apparatus convinces us that there is room for a living being: and while this appears to be the case, there is no occasion to call in the aid of more complex machinery.

An ingenious author has demonstrated the truth of this opinion; and has shown how A FULL-GROWN MAN may be concealed in the machine, and may take the successive positions which are rendered necessary during the preliminary stratagem, as well as during *the progress of the game*. The following description

will exhibit the principal arguments which he employs. *Fig.* 1 (in the plate) represent the general appearance of the machine. It runs on castors, and is either seen on the floor when the doors of the apartment are thrown open, or is wheeled into the room at the commencement of the exhibition.

The exhibitor, in order to show the mechanism, as he informs the spectators, unlocks the door of the chest, which exposes to view a small cupboard, lined with black or dark-coloured cloth, and containing different pieces of machinery, which seem to occupy the whole space. He next opens a door at the back of the same cupboard, and holding a lighted candle at the opening, still further exposes the machinery within. The candle being withdrawn, the back door is then locked. The drawer (G G, *Fig.* 1) in the front of the chest is then opened, and a set of chess men, a small box of counters, and a cushion for the support of the automaton's arm, are taken out of it. The exhibitor now opens the front doors (C C, *Fig.* 1) of the large cupboard, and the back door of the same, and applies a candle, as in the former case. This cupboard is lined with cloth like the other, but it contains only a few pieces of machinery. The chest is now wheeled round, the garments of the figure lifted up, and the door in the body of the figure, and another in the thigh, are opened. But it must be observed that the two side doors at the back are closed.

The chest is now restored to its former position on the floor; the doors in front, and the drawer, are closed and locked; and the exhibitor, after he has occupied some time at the back of the chest, in apparently adjusting the machinery, removes the pipe from the hand of the figure, winds up the works, and the automaton begins to move.

The eagerness of the exhibitor to display part of the machinery at one time, and his studied concealment of it at another; *the regular and undeviating mode of disclosing the interior of the chest;* and the various facts which have been observed respecting *the winding up of the machine*; afford positive proof

that the axis turned by the key is quite free and unconnected either with a spring or a weight, or any system of machinery.

But it will be seen that any person well skilled in the game, and not exceeding the ordinary stature, may secretly animate the automaton, and imitate the movements of the chess player, which may be easily understood by what follows:—

The drawer (G G, *Fig.* 1,) when closed does not reach to the back of the chest, it leaves a space behind it, about one foot two inches broad, eight inches high, and three feet eleven inches long. This space is never exposed to view.

The small cupboard is divided into two parts by the door or the screen (I, *Fig.* 3,) which is moveable on a hinge, and is so contrived, that when B is closed this screen may be closed also. The machinery (H) occupies the whole front of the division as far as I; the hinder division is nearly empty, and communicates with the space behind the drawer, the floor of this division being removed.

The back of the great cupboard is double, and the part to which the quadrants, &c. are attached, moves on a joint at the upper part, and forms, when raised, an opening between the two cupboards, by carrying with it part of the partition which is composed of cloth stretched tight.

When the trunk of the figure is exposed by lifting up the dress, it will be seen that a great part of it is occupied by an inner trunk (N, *Fig.* 3,) which passes off towards the back in the form of an arch, and conceals a portion of the interior from the view of the spectators. This inner trunk opens to the chest by an aperture about one foot three inches high by one foot broad.

When the false back is raised, the two chambers, the trunk, and the space behind the drawer, are all connected together.

The player may be introduced into the chest by the sliding pannel (U, *Fig.* 3,) at the end. He will then elevate the false back of the large cupboard, and

assume the position represented by the dotted lines in *Fig.* 2. Every thing being thus prepared "the charm 's wound up," and the exhibitor may begin his operations by opening the door A. From the crowded and very ingenious disposition of the machinery in this cupboard, the eye is unable to penetrate far beyond the opening, and the spectator is led to conclude that the whole space is occupied by a similar apparatus. This illusion is strengthened and confirmed by observing the glimmering light which plays among the intricacies of the machinery, and occasionally meets the eye when the lighted candle is held at the back door. A fact, too, is ascertained, which is equally satisfactory, though for opposite reasons, to the spectator and the exhibitor, viz. that no opaque body of any magnitude is interposed between the light and the spectator's eye. The back door must now be locked, and the screen (I) closed, which being done at the moment the light is withdrawn, will wholly escape observation.

It has been already mentioned, that the back door from its construction, closes by its own weight; but as the player's head will presently be very near it, the secret would be endangered, if, in turning round the chest, this door were, by any accident, to fly open; it becomes necessary, therefore, "to make assurance doubly sure," and turn the key. If the circumstance should be observed, it will, probably, be considered as accidental, the keys being immediately wanted for the other locks.

The back door being once secured, and the screen closed, the success of the experiment may be deemed complete. The secret is no longer exposed to hazard; and the exhibitor is at liberty to shape his conduct in any way he may think most likely to secure the confidence of the spectators, and lead them insensibly from the main object of pursuit. The door (A) may safely be left open; this will tend to confirm the opinion, which the spectators probably formed on viewing the candle through this cupboard, that no person was concealed within: it will further assure them that

nothing can pass in the interior without their knowledge, so long as this door continues open.

The drawer stands next in the order of succession: it is opened, *apparently*, for the purpose of taking out the chess men, cushion, &c. but *really* to allow time for the player to change his position, and to replace the false back and partition preparatory to the opening of the great cupboard.

The chest may now be wheeled round for the purpose of showing the trunk of the figure; leaving, however, the front doors of the great chamber open. The bunch of keys, too, should be suffered to remain in one of the side doors at the back; for the apparent carelessness of such a proceeding will serve to allay any suspicion which the locking the other side back door might have excited, more especially as the two doors resemble one another in point of construction.

When the drapery has been lifted up, and the doors in the trunk and thigh opened, the chest may be returned to its former situation, and the doors be closed. In the mean time the player should withdraw his legs from behind the drawer, as he will not so easily effect this movement after the drawer has been pushed in.

When the doors in front have been closed, the exhibitor may occupy as much time as he finds necessary in apparently adjusting the machinery at the back, whilst the player is taking the position described at *Fig.* 4. In this position he will find no difficulty in executing every movement required of the automaton: his head being above the table, he will see the chessboard through the waistcoat as easily as through a veil; and his left hand extending beyond the elbow of the figure, he will be enabled to guide its hand to any part of the board, and to take up and let go a chess man with a string communicating with the finger. His right hand being within the chest, may serve to keep in motion the contrivance for producing the noise which is heard during the moves, and to perform the other tricks of moving the head, tapping on the chest, &c.

In order to facilitate the introduction of the player's left arm into the arm of the figure, the latter is obliged to be drawn backwards; and to account for and conceal this strained attitude, a pipe is ingeniously placed in the automaton's hand. This pipe must not be removed till the other arrangements are completed.

When all is ready, and the pipe removed, the exhibitor may turn round the winder, to give the impression to the spectators of winding up a spring, or weight, and to serve as a signal to the player to set the head of the automaton in motion.

The above process is simple, feasible, and effective; showing, indisputably, that the phenomena may be produced without the aid of machinery, and thereby rendering it probable that the chess player derives his merit solely from the very ingenious mode by which the concealment of a living agent is effected.

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Method of taking Casts of Leaves and Foliage.

Mr. Deeble's object in making casts from the natural leaves, was to supply himself with fac-similes of the form and texture of those plants which, as an engraver, he might have to introduce into the foreground of landscapes. Artists are not always so circumstanced, that they can go out and study in the fields: and the plant he may wish to copy may not be in season when he needs it. These considerations led to the following process for obtaining fac-similes.

The leaf, as soon as convenient after being gathered, is to be laid on a fine-grained moist sand in a perfectly natural position, having that surface uppermost which is to form the cast, and being banked up by sand, in order that it may be perfectly supported. It is then, by means of a broad camel-hair brush, to be covered over with a thin coating of wax and Burgundy pitch, rendered fluid by heat. The leaf being now removed from the sand, and dipped in cold water, the wax becomes hard, and at the same time sufficiently tough

to allow the leaf to be ripped off without altering its form. This being done, the wax mould is placed on moist sand, and banked up as the leaf itself was; it is then covered with plaster of Paris made thin, care being taken that the plaster is accurately forced into all the interstices of the mould by means of a camel-hair brush. As soon as the plaster has set, the warmth thus produced softens the wax, which in consequence of the moisture of the plaster, is prevented from adhering thereto, and with a little dexterity it may be rolled up, parting completely from the cast, without injuring it in the smallest degree.

Casts thus obtained are very perfect, have a high relief, and are excellent models either for the draughtsman, or for the moulder of architectural ornaments.

To make Odoriferous Pastiles.

Of benzoin gum and frankincense, each two and a half drachms; gum myrrh, gum styrax, cascarilla bark, in powder, and nitrate of potass, of each one and a half ounce; mixed and formed into a mass with mucilage of gum arabic, and oil of turpentine.

Another method.

Of camphor, flowers of benzoin, powdered charcoal, powdered cascarilla bark, powdered Turkey myrrh, powdered nitre, each equal quantities; beat them up with syrup sufficient to form a mass, and divide into pastiles of a conical form; or they may be mixed with rectified spirit of turpentine.

Lithographic Paper.

M. Senefelder, the celebrated inventor of the *lithographic art,* has lately prepared a kind of paper

or card, as a substitute for the magnesian lime stone usually employed. This card is covered on one or both faces with an argillo-calcareous mixture, which has the property of receiving the ink or the crayon in the same way that the stone does, and of undergoing the ordinary preparation, and furnishing impressions as neat and perfect as those obtained from designs traced on stone.

Preparation of Quills.

A boiler is to be about one-fourth part filled with water, and the quills suspended in a perpendicular position over the surface of the water, with their tails downwards, so the extremity of the tail is not below the surface of the water. The boiler is then to be close covered, and kept boiling four hours. The next day, having cleared the quills of roughness, and rubbed them with a piece of woollen cloth, let them be exposed to a moderate degree of heat, and on the following day they will be found hard and transparent, and without the defect of splitting too freely.

Black Resinous Varnish.

This beautiful black varnish, celebrated for its lustre and durability, is prepared in the following manner: the nuts of the *Semacarpus Anacardium*, and the berries of the *Holigarna longifolia*, having been steeped a month in clear water, are cut transversely and pressed in a mill. The expressed juice is kept for several months, and the scum taken off from time to time. The liquor is then decanted, and *two* parts of the Semacarpus are added to *one* part of the Holigarna. The varnish is laid on like paint, and is polished by rubbing it when dry, with an agate or smooth pebble.

Manufacture of Cat-gut Strings.

The cat-gut strings used for harps and violins, are manufactured in Whitechapel, &c. of the peritoneal covering of the intestines of the sheep; but have always been considered inferior to those exported from Italy. Dr. Mac Culloch ascribes this superiority to the leanness of the Italian sheep:—it is known, that the membranes of lean animals are stronger than those of fat ones; and he suggests, that the cat-gut should be manufactured from the Welch, Highland, or South-down breeds, in preference to those which, like the Lincoln, are prone to excessive accumulations of fat.

Delicate Instrument for ascertaining the State of the Atmosphere.

A portion of the oat-beard cemented to a piece of paper makes a valuable instrument for this purpose. As the oat-beard untwists with moisture, the index (made of straw) moves the same way round as the hand of a watch, and thus moving, coils the string round the straw tube or axis, by which means the number of revolutions from any time observed may be known, and thus the confusion will be avoided, which is occasioned by the index moving more than once round, which it does in passing from extreme dryness to wet.

The spring may be so placed as to wind up when the index moves the contrary way, that is, from moist to dry, if the maker so chuses; and in this case the circle must be numbered the contrary way from the above. The oat-beard is fixed, and the index is not to be turned or set to a certain point, as is the case with the common hygrometer, by a contrivance behind the case. The method of keeping a register of this hygrometer will be thus:—

When on the upper part of the axis there is one *coil, and the index* points at 6, set down 1—6, *two coils,* ..... 6, ... 2—6, &c.

If the circle be divided into 100 divisions, the reckoning will be no coil,

and the hand at 10, set down 10,
1 coil, ... 10, ... 110,
2 coils, ... 10, ... 210, &c.

which, if the circle be large enough, will be a very convenient mode of registering.

Tree of Crystals.

Put a small quantity of bruised gum benzoin on a piece of thin metal or a saucer; invert over it a tumbler-glass in which place a sprig of heath, or any small-leaved plant; and apply the flame of a candle underneath, so as to melt the gum: dense fumes will soon begin to arise, and deposit themselves in most beautiful crystals of a silky texture, on the sprig of heath, in delicate soft flakes, resembling foliage.

A Ball of Ice.

Introduce a small portion of water into a thin glass ball, and keep it moistened for a considerable length of time by the application of sulphuric ether; and the water will be converted into ice.

Beautiful Metallic Crystals.

Over one ounce of iron filings in a tea cup, pour a table-spoon full of sulphuric acid, diluted with four times its quantity of water; boil it for a short time, and set it aside to cool, when beautiful crystals of sulphate of iron will be formed.

Method of making the Iris Metal Ornaments.

Mr. Barton, of the Mint, a gentleman well known for his ingenuity and his mechanical attainments, has recently conceived the happy idea of ornamenting steel and other articles with the colours of striated surfaces, and has secured, by patent, the exclusive privilege of applying this principle to practical purposes. The excellence of Mr. Barton's engine has, no doubt, enabled him to execute this kind of work with a beauty and precision which no other person can hope to imitate; its merits depend chiefly on the beauty and correctness of the screw. The plate in the screw is not divided higher than the two hundredth part of an inch; but Mr. Barton has drawn divisions on steel and glass so minute as the ten thousandth part of an inch. In drawing lines of two thousand in an inch, Mr. Barton often leaves out *one line* intentionally; and one of the greatest proofs of the stability of the engine is, that after having taken it off the brass table with the work upon it (when the omission is distinctly perceived), *he can restore it to its place, and introduce the line, without its being distinguishable from the rest.*

In applying the principle of striated colours to ornament steel, the effect or pattern is produced upon the polished surface by the point of a diamond, so that either the whole or a part of the surface is covered with lines or grooves, whose distance may vary from the thousandth to the ten thousandth of an inch. When these lines are *most distant*, the prismatic images of the candle, or any luminous body seen by reflection from the polished surface, are *nearest* one another, and the common colourless image; and when the lines are *least distant* the coloured images are *farthest* from one another, and the colours are most vivid.

In daylight the colours produced by these minute grooves are scarcely distinguishable, unless at the boundary between a dark and a luminous object; and we *conceive* that their brilliancy will be very

much impaired, even with artificial lights, when they are dispersed by the interposition of globes, or hemispheres of ground glass.

In sharp lights, however, and particularly in that of the sun, the colours shine with extraordinary brilliancy, and the play of tints which accompany every luminous image can only be equalled by their matchless exhibition in the reflections of the diamond. The surface of fine steel, therefore, when grooved by a skilful hand, is peculiarly fitted for imitative jewels and other articles of female dress, and we have no doubt that it will find an application to many other purposes both of use and ornament.

The divisions which Mr. Barton most commonly uses for his metal ornaments are two thousand to an inch; but, when the material is good, his engine enables him to divide to five thousand and ten thousand. When the lines, however, are so close, the labour is very great; but the beauty of the work is generally a compensation for the time bestowed upon it, as the strength of the colour increases with the number of lines. The depth of the line has a great effect in producing brilliancy, owing to the increase in the quantity of reflected light; and the depth may be in some measure judged of by the faintness of the reflected image of the eye, when looking perpendicularly at the steel, until, at last, by totally removing the original surface, in consequence of the edges of the cut meeting, the whole surface looks black, and the eye is no longer seen.

Preparation of Fulminating Silver.

Take three drachms of crystallized nitrate of silver reduced to powder, put it into a bason, and pour over it two ounces and a half of alcohol, and add seven drachms, by measure, of concentrated nitrous acid. The mixture will instantly become hot, and a violent effervescence will speedily take place; it also

gradually becomes milky and opake, and a white powder becomes deposited. When the action has nearly ceased, and the mixture acquired consistency, add gradually water to it to suspend the further action. Then wash the white precipitate by repeated effusions of cold water, and suffer it to dry in the open air, in a dark place, or secluded from the light, by covering it with a few sheets of paper.

This compound requires the utmost care; it should never be included in a phial, nor should it be touched or handled in any way that can produce a considerable friction; it explodes whilst wet, or under a fluid, when touched with a glass rod; it explodes also when touched with a glass rod moistened with sulphuric acid. A grain or two applied to a piece of paper, and made to approach a candle, explodes with extreme violence.

This celebrated compound arrests the attention of the curious in the form of various toys, called fulminating balls, bombs, &c., which explode when suffered to fall on the ground. Fulminating balls are hollow, small globules of very thin glass rather larger than a pea, containing a grain or two of fulminating silver. The best method of exploding them is to crush them under the heel of the foot. They are prepared as follows:—Introduce one or two grains of fulminating silver into a hollow glass globule, and secure it by pasting over the opening or neck of the globule a piece of soft paper, which should also be extended over the whole ball so as to cover it completely. Fulminating bombs are balls the size of a hazel-nut, containing about three grains of fulminating silver. They should never be exploded by crushing them under the heel of the foot, because their explosive effect is prodigiously violent.

Curious Experiment with a Piece of Brown Paper.

Give a piece of brown paper a spherical form, by *pressing it upon* any hard globular substance. Gra-

dually bring the paper thus formed to that distance from a candle at which it will begin to take fire. In this case a beautiful blue flame may be seen hanging, as it were, by the paper till a hole is made in it, when the flame, owing to the increased action of the air upon all parts of it becomes white, though the edges still continue of a blue or violet colour.

Beautiful Experiment with Phosphorus.

Into a deep cylindrical glass not above three parts filled with water put a piece of phosphorus, which, when thus immersed, will make bright and vigorous coruscations in the air. This fiery meteor is contracted in its passage through the water, but expands as soon as as it gets above it.

This effect will be produced in warm weather only.

Singular Hydraulic Experiment.

If a jet of water about one-eighth of an inch in diameter be impelled from a tube, a conical cup may be suspended about four feet from the pipe so that the cup will continue to oscillate on the extremity of the fluid column.

This experiment may be varied and improved by placing lighted tapers or a coloured fire-work on the metal cup; it will, indeed, form a fire-water work.

To freeze Quicksilver.

Quicksilver, though always in a fluid state at any usual natural temperature, owes this form to the agency of caloric; it is a solid metal, and by a sufficient reduction of temperature can be obtained in the solid state.

Solid mercury possesses an evident degree of malleability, as it can be flattened with a hammer; it is somewhat flexible, and may be extended without breaking; it is not possible to estimate its ductility. Its hardness, when thus near to its melting point, does not appear to be considerable. In congealing it assumes a crystalline structure and form. In its structure it presents the appearance of striæ diverging from different centres; and when the liquid part is withdrawn from a quantity partially congealed, small octahedral crystals are discoverable.

If the congealation of mercury is wanted to be exhibited in a miniature process, the readiest way is to throw a little of the metal loose into a pretty large mass of a freezing mixture, composed of snow and muriate of lime, where it will congeal in a few minutes. It is of importance that the snow should remain without doors till the moment that it is wanted, and the whole of the muriate should be kept cold, by immersing in snow or iced water the vessel that contains it.

Great caution should be used in touching frozen mercury; it gives an immediate sensation like a wound from a rough-edged instrument, or as if the finger was squeezed in a vice, and the mere sensation can hardly be distinguished from the burn of a red-hot iron. The part in contact immediately becomes quite white and numb; and there is no doubt, that if it were to remain a very little time in contact with the frozen metal, a local gangrene, like that of a common frost-bitten limb, would come on. It is removed by rubbing the part a little time with snow.

Test to detect Acids.

Immerse a slip of litmus paper into any sort of wine, cider, ale, porter, or any other fermented liquor, its natural blue colour will become changed to red, *because all vinous* fluids, even the mildest, con-

tain a free acid, some more, others less. The redness occasioned by vinous liquors on litmus paper is owing to the presence of tartaric, malic, or acetic acid.

Paper, stained with the juice of the violet flower, or the scrapings of purple radishes, answers the same purpose.

The colour of litmus paper ought to be a pale, not a dark violet hue. This paper, when long exposed to the contact of air and light, loses its colour, and then becomes unfit for use; it should, therefore, be preserved in opake-stopped bottles, or placed between the leaves of a book.

Preparation of Litmus Paper.

Litmus paper is prepared by dipping fine writing-paper into tincture of litmus, and suffering it to dry slowly. The paper should first be freed from the portion of glue, alum, and other foreign matters, which all writing-paper contains, and this may be done by a repeated effusion of distilled water.

New Construction of Magic-Lanthorn Sliders.

A very beautiful mode of exhibiting an optical fountain is described below.

Take a frame of brass of the same size and thickness as a magic-lanthorn slider, and introduce a number of pieces of twisted glass, so that they may all be made to revolve in conjunction by turning a handle provided for the purpose. If the frame be now introduced into the lanthorn, and a painted plate of glass representing a fountain be placed in the front, it will be found, that when the twisted glass is turned, streams of water will appear to ascend on the screen in the most perfect way possible.

The Eye described as an Optical Instrument.

The eye is of a globular form, and composed of three *coats* or teguments, one covering the other. The external *coat* or case, which forms the globe of the eye, is at the back part strong and opake; the fore part is thin and transparent, so as to admit readily the rays of light, and it is therefore called the *cornea*, from its resemblance to polished horn. It encloses three pellucid matters called the *humours*, which are of different densities. That in the anterior part, immediately under the cornea, is called the *aqueous humour*; that immediately behind is the *crystalline humour*, which is a double convex lens of great refracting power; and the rest of the eye is filled with a jelly-like substance called the *vitreous humour*. The *iris*, which is the coloured part of the eye, is an opake membrane, which is perforated by a small hole, the *pupil* through which the rays of light must pass to the crystalline humour. The optic nerve enters at the under part, and is spread all over the interior surface, at the back of the eye, in the form of a fine net-work, and therefore is called the *retina*. Thus, it will be seen, that the eye is altogether calculated to act as a convex lens of strong refractive powers.

From every luminous point of a visible object cones or pencils of light are limited or reflected in every direction; but to produce vision, it is necessary that they should be concentrated or converged to such a point as to make a forcible impression on the retina. Thus, from the luminous body A, *Fig.* 5. the rays *r r r* are sent in various directions. Those which fall upon the transparent cornea C C, are there refracted in such a manner as to enter the pupil at *p*, and in passing the crystalline lens or humour they suffer a second refraction, and are converged to a point or focus at the point *a* on the retina. Now, it is evident, that if the rays could have passed the humours of the eye in their natural direction, that

is, in the direction of the cone or pyramid C, A, C, they would have made upon the retina a very extensive but feeble impression, such as we know by experience could not produce distinct vision. To obviate this, by the force of the refraction which they suffer in the eye, they form another cone opposed to the first at its base, and the apex of which is at *a*, and thus an impression sufficiently forcible to produce distinct vision is made on the retina.

We may verify by experiment what has been said of the cause of vision, by taking the eye of an ox recently killed, and dexterously removing the posterior coats to the vitreous humour; and if a piece of white paper is then placed at the part, the image of any bright object which is placed before the eye will be seen distinctly painted on the paper, but in an inverted position.

Artificial eyes are sold at the opticians, in which all the humours are made of different kinds of glass, and may be separated at pleasure. At the back part, where the retina is supposed in the natural eye to receive the converged rays, is placed a piece of ground glass, where the image from the opposed objects is represented in an inverted position, as in a camera-obscura.

The Kaleidoscope.

The principal parts of the kaleidoscope are two reflecting planes made of glass or metal, or any other reflecting substance, ground perfectly flat, and highly polished. These reflectors may have any magnitude, but, in general, they should be from four or five to ten or twelve inches long, their greatest breadth being about an inch when the length is six inches, and increasing in proportion as the length increases. When these two plates are put together at an angle of 60°, or the sixth part of a circle, and the eye placed at the narrow end, it will observe the opening multiplied six times, and arranged round the centre.

On the Selection of Objects for the Kaleidoscope.

Although the kaleidoscope is capable of creating beautiful forms from the most ugly and shapeless objects, yet the combinations which it presents, when obtained from certain forms and colours, are so superior to those which it produces from others, that no idea can be formed of the power and effects of the instrument unless the objects are judiciously selected.

The objects which give the finest outlines by inversion, are those which have a curvilineal form, such as circles, ellipses, looped curves like the figure 8, curves like the figure 3 and the letter S; spirals and other forms, such as squares, rectangles, and triangles, may be applied with advantage. Glass, both spun and twisted, and of all colours and shades of colours, should be formed into the preceding shapes; and when these are mixed with pieces of flat-coloured glass, blue vitriol, native sulphur, yellow orpiment, differently coloured fluids enclosed and moving in small vessels of glass, &c., they will make the finest transparent objects for the kaleidoscope. When the objects are to be laid upon a mirror plate, fragments of opaquely-coloured glass should be added to the transparent fragments, along with pieces of brass wire, of coloured foils, and grains of spelter. In selecting transparent objects, the greatest care must be taken to reject fragments of opaque glass, and dark colours that do not transmit much light, and all pieces of spun glass or coloured plates should be as thin as possible.

Magic Squares.

The magic square is a square figure formed of a series of numbers, in mathematical proportion, so *disposed in parallel* and equal ranks as that the sums

of each row taken either perpendicularly, horizontally, or diagonally, are equal.

The several numbers which compose any square number (for instance, 1, 2, 3, 4, 5, &c. to 25 inclusive, which compose the square number 25), being disposed after each other, in a square figure of 25 cells, each in its cell,—if, then, you change the order of these numbers, and dispose them in the cells in such a manner, as that the five numbers which fill any horizontal rank of cells being added together, shall make the same sum with the five numbers on any other rank of cells, whether horizontal or vertical, and even the same number with the five in each of the two diagonal ranks: this disposition of numbers is called a magic square, in opposition to the former disposition, which is called a natural square.

Natural Square.

1	2	3	4	5
6	7	8	9	10
11	12	13	14	15
16	17	18	19	20
21	22	23	24	25

Magic Square.

11	24	7	20	3
4	12	25	8	16
17	5	13	21	9
10	18	1	14	22
23	6	19	2	15

Suppose a square of cells, whose root is uneven, for instance, 7, and that its 49 cells are to be filled magically with numbers, for instance, the first 7, or the one side take the first seven numbers, beginning with unity, and ending with the root 7, and on the other 7 and all its multiples to 49 exclusively; and as these only make six numbers, add 8, which makes this an arithmetical progression of seven terms as well as the other, 0, 7, 14, 21, 28, 35, 42. This done with the first progression repeated, fill the square of the root 7 magically: in order to do this write in the first seven cells of the first horizontal rank the seven numbers proposed, in what order you

please, for that is perfectly indifferent; and it is proper to observe here, that those seven numbers may be ranged in 5040 different manners in the same rank. The order in which they are placed in the first horizontal rank, be it what it will, is that which determines their order in all the rest. For the second horizontal rank, place in its first cell either the third, the fourth, the fifth, or the sixth number, from the first number of the first rank, and after that write the six others in order as they follow. For the third horizontal rank, observe the same method with regard to the second that you observed in the second with regard to the first, and so of the rest. For instance, suppose the first horizontal rank filled with the seven numbers in their natural order, 1, 2, 3, 4, 5, 6, 7, the second horizontal rank may either commence with 3, with 4, with 5, or with 6, but in this it commences with 3.

1	2	3	4	5	6	7
3	4	5	6	7	1	2
5	6	7	1	2	3	4
7	1	2	3	4	5	6
2	3	4	5	6	7	1
4	5	6	7	1	2	3
6	7	1	2	3	4	5

The third rank therefore must commence with 5, the fourth with 7, the fifth with 2, the sixth with 4, and the seventh with 6. The commencement of the ranks which follow the first being thus determined, the other numbers, as we have already observed, must be written down in the order wherein they *stand in the first*, going on to 5, 6, and 7, and *returning to 1, 2,* &c., till every number in the first

rank be found in every rank underneath, according to the order arbitrarily pitched upon at first. By this means, it is evident, that no number whatever can be repeated twice in the same rank; and, by consequence, that the seven numbers, 1, 2, 3, 4, 5, 6, 7, being in each rank, must, of necessity, make the same sum.

The Magical Square.

The Chinese have discovered mystical letters on the back of the tortoise, which is the common magical square, making each way 15, viz.

2	9	4
7	5	3
6	1	8

Writing in Cipher.

A cipher, consisting of nine radical characters, (those, for instance, composing the well-known figure ++ ++ with one, two, three, or more points at pleasure above, below, or in the body of the figure,) is sufficient to compose a great enough variety of secret symbols for any purpose.

Plate Electrical Machine.

The plate electrical machine consists of a circular plate of glass revolving on an axis which passes through its centre (*see Fig.* 6), the excitation is effected by two pairs of cushions placed at opposite *parts of the* circumference of the plate. The cush-

ions are loosely attached to thin pieces of mahogany, and the pressure upon the plate is adjusted by screws which pass through the opposite pieces. A brass conductor, supported by a glass arm, is fixed to one pillar, or in large ones to the bottom of the frame of the machine, carrying two branches expanding beyond the periphery of the plate. The extremities of the conductors are furnished with points in order to collect the electricity from the excited surface.

To strike Gold Leaf into Glass.

Take two slips of common window glass, each about an inch broad, and four inches long, then take a slip of gold or silver leaf about the breadth of a straw, and six inches in length, and put it between the glasses lengthwise in the middle, letting the ends of the leaf hang down an inch without the glasses at each end. Tie the glasses close together by wrapping a strong silk thread round them, and lay them down on the table, so that one end of the metal leaf may be in contact with the coating at the bottom of a jar, placed so that it may be charged at the prime conductor. Then charge the jar, and having put one end of the discharge upon that part of the leaf that lies without the glass slips at the farthest end from the jar, apply the other end of the discharger to the ball on the top of the jar-wire, and all the fire in the jar will be discharged through the metal leaf. If the slips of glass remain whole, you will see that the leaf is missing in several places, and instead of it a metallic stain upon both the glasses exactly alike. When they are taken asunder, you will observe that the leaf has been melted by the electric lightning, and actually driven into the very substance of the glass, as neither *aquafortis* nor *aqua regia* will take it off.

To freeze Water in Summer without the Application of Ice.

Take eleven drachms of muriate of ammonia, ten of nitrate of potash, and sixteen of sulphate of soda, reduce each of these salts separately to a fine powder, and mix them gradually in a glass vessel, or thin metal is better, with five ounces of water (the capacity of the vessel should be just only large enough to hold the materials), the result will be, that as the salts dissolve cold will be produced, and a thermometer * immersed in the mixture will sink at or below freezing. A little water, about half an ounce, in a test-tube, when immersed in the mixture during its solution, becomes frozen in about ten minutes.

Preparation of a Metallic Variegated Powder.

Prepare clean filings of copper, brass, iron, steel, and other metals. Put each of them separately into an iron vessel, and heat them till they change colour. The degree of heat can only be regulated by trial. Take these filings to a flatting-mill, furnished with a funnel at the top, and pass them through it. A most sparkling powder of all sorts of lively colours will be the result.

Test to distinguish Iron from Steel.

To distinguish iron from steel by a chemical process, take nitric acid, dilute it with so much water

* The best thermometers for all useful, chemical, and philosophical experiments, are those which exhibit the entire range of thermometrical temperature from the freezing to the boiling point of mercury, and which are furnished with a joint or sliding hinge to allow the lower part of the scaleboard to fall back, in order to leave the bulb and part of the tube bare, so that it may safely be immersed into acids, or other corrosive fluids, without occasioning any injury to the board on which the scale is delineated.

that it will only feebly act upon the blade of a common table knife. If a drop of the acid thus diluted be put upon steel, and allowed to remain on it for a few minutes, and then washed off with water, it leaves a *black* spot; but if a drop of the same acid be put upon iron the spot will not be black, but of a whitish grey colour.

To prevent the Fracture of Lamp Glasses.

The glass chimneys which are now in such extensive use not only for oil lamps, but also for the burners of oil and coke gas, very frequently break, and not only expose to danger those who are near them, but occasion much expense and inconvenience, particularly to those who are resident in the country. The bursting of these glasses very often arises from knots in the glass, where it is less perfectly annealed, and also from an inequality of thickness at their lower end, which prevents them expanding uniformly by heat. The best method of detecting the knots is to examine the glasses by polarized light, and reject those that exhibit at the knots the depolarized tints. The evil arising from inequality of thickness may be cured by making a cut with a diamond in the bottom of the tube; and it is worthy of remark, that in establishments where six lamps are lighted every day, and where this precaution was taken, there was not a single glass broken for nine years.

Bramah's Locks.

A lock of five slides admits of 3000 variations, while one of eight will have no less than 1,935,360 changes, or, in other words, that number of attempts at making a key, or at picking it, may be made before it can be opened. This difficulty, great as it is, has been increased an hundred fold by an improvement of his son's. The security of Bramah's

locks depends on the doctrine of combinations, or multiplication of numbers into each other, which is known to increase in the most rapid proportion.

Capillary Attraction.

If one end of a skein of thread be put into a vessel of water, while the other hangs over the side, it will very soon become a conductor of the liquid, which will filter and run off until the vessel is nearly empty.

Sympathetic Ink.

Dissolve a crystal of sulphate of copper in a wine-glass full of water, and with this solution write or sketch any thing on paper—no characters will be visible. Moisten the writing with a feather dipped into a diluted solution of prussiate of potash, and the letters will appear of a beautiful *blue*.

Shower of Snow.

Take a phial filled with aquafortis, and set it by the fire till it is warm: then introduce filings of pure silver. When the aquafortis is saturated with silver, wipe the phial clean, and put the solution in a cold place; it soon becomes transparent, and the silver particles, like those of water, will shoot into crystals. These in a short time will descend very rapidly to the bottom of the fluid, forming a perfect shower of snow.

Discoveries.

Dr. Black discovered carbonic acid and latent heat.

Mr. Cavendish hydrogen, the composition of water and nitric acid.

Dr. Priestly nitrous gas, the existence of ammonia, and several of the acids in an aërial form, and oxygen gas.

Scheele also discovered oxygen gas, azote, and the composition of atmospheric air.

Lavoisier overturned Stahl's system, and introduced a new theory.

Dalton the theory of definite proportions.

Sir H. Davy the metallic bases of the earths and alkalies.

Splendid Light.

A splendid instance of light produced during crystallization was observed by M. Buchner, during the sublimation of benzoic acid, previously mixed with pulverized carbon. The sublimation was carried on in a tall glass cylinder upon a stove, and when it had well begun, there appeared an uninterrupted succession of sparks continuing for half an hour, and which ceased only when the cylinder was removed from the stove.

To preserve Furs, &c., from the Attacks of the Moth.

A mixture of *alcohol* (spirit of wine) with *corrosive sublimate* (perchloride of mercury) made very strong. This liquid is colourless, and will not soil the most delicate fur; it is a spirit, and diffuses itself rapidly through the skin; it is antiseptic, and preserves from decay, and of all poisons known it is the most deadly to insects.

Another Method.

Put a small piece of sponge on which spirit of *turpentine has been* poured into the drawer in which

furs are kept, closely shut the drawer, and the insects will be dead in half an hour.

Beautiful Chemical Experiments.

1. Drop gradually small pieces of carbonate of ammonia (strong smelling salts) into a goblet containing nitric acid, slightly diluted with water, as long as any effervescence continues; pour the solution into a china saucer, and place it near the fire (free from dust) till a considerable part of the liquid be evaporated, then remove it into a cool place, and beautiful needle-like crystals will be formed.

2. Take an ounce of saturated solution of carbonate of soda, and add to it half an ounce of sulphuric acid, set it aside, and in a short time crystals of sulphate of soda will be produced.

3. Moisten the interior of a tumbler-glass with a large feather previously dipped in muriatic acid, and also moisten the inside of another tumbler with liquid ammonia; bring the mouths of the glasses together, and the two gases (previously invisible) will unite, producing white fumes, which will deposit themselves in a crystalline form on the sides of the glass.

4. Dissolve a portion of sub-carbonate of potash in a glass containing water, and add to it nitric acid as long as any effervescence continues; then pour the liquid into a saucer, and place it near the fire till a portion of the water is evaporated: remove it into a cool place, and hexahedral prismatic crystals will be formed.

5. Evaporate any quantity of milk-whey to the consistence of honey, and suffer it to cool. Dissolve the mass in water, and clarify it by the addition of the white of eggs. Filter and evaporate it to the consistence of syrup: when cool, beautiful white crystals will be deposited.

6. Dissolve three quarters of an ounce of sulphate

of soda in one ounce of boiling water; pour the solution while hot into a phial, and cork it close: when perfectly cool the mixture will still be fluid; but by removal of the cork crystallization will commence, and proceed with great rapidity.

If the above effect does not *immediately* take place on the removal of the cork, drop into it a crystal of the salt, and the effect will instantaneously be produced.

Remarks.

When the laws of crystallization are allowed to perform their functions uncontrolled, the beautiful geometrical forms which they create are marked with the most perfect regularity. Even their physical properties are symmetrically related to some axis or fixed line; and though all their functions are performed in utter silence and repose, yet their physiology, if we may apply that name to the actions of apparently dead matter, is not less wonderful than that which embraces the busy agencies of animal and vegetable bodies.

Preservation of Crystals.

It is sometimes an object to preserve good crystals of salts, especially with those who are attentive to the study of crystallography. In attaining this end, much assistance may be derived from the use of sweet oil. Many crystals which change, and become dull by exposure to air, as alum, sulphate of copper, sulphate of iron, prussiate of potash, &c., if slightly oiled, do not then alter in a long time; and many efflorescent substances are prevented changing by the same means. Even crystals of Glauber's salt may be exposed to the air for weeks.

Mechanical Means for Copying Drawings.

To trace against the light hold the drawing y wish to copy against one of the panes of the wind or have a pane of glass put into a frame, and fit up like a music stand, with a candle behind it. I the paper over the drawing, and you will see all lines of the original distinctly through it, by wh means you can easily trace them with a pen or bla lead pencil.

To make Tracing Paper.

Mix together equal parts of oil of turpent and drying oil, and with a rag rub it evenly o some fan or tissue-paper, or any other very t paper. Hang it by to dry for a day or two, an will be fit for use. Lay this over the drawing y wish to copy, and you will see every line distinc through, so that you can go over them with a bla lead pencil. If you wish to do it in ink, mix a li ox gall with the ink to make the paper take which it would not otherwise do on account of oil.

To make Camp Paper.

Take some hard soap, mix it with lamp-bla make it into the consistence of a jelly with wat with this brush over one side of the paper, and le dry. When you use it, put it between two sheets clean paper, with its black side downwards, and w a sharp point draw or write upon the clean pap and where the tracer has touched, there will be impression upon the lowermost sheet of paper a it had been written or drawn with a pen. It may made of any colour, by mixing with the soap bla lead, vermillion, &c.

Stencilling.

Lay the drawing you wish to copy over a sheet of paper, and with a needle prick all the outline over with holes through both the papers; then take the clean paper with the holes made in it, and lay it upon the paper you wish to have the design transferred to, and dust it over with the powder of charcoal from a small muslin bag, the dust will penetrate through the holes, and leave a correct copy of the original upon the paper.

This pricked paper will do again for any number of copies.

Magnetic Perspective Glass.

Provide an ivory tube about two inches and a half long, and of the form expressed at *Figs.* 7 and 8. The side of this tube must be thin enough to admit a considerable quantity of light. It is to open at one end with a screw, at which end there must be placed an eye-glass of about two inches focus, and at the other end any glass you please. Have a small magnetic needle like that placed on a compass; it must be strongly touched, and so placed at the bottom of the tube that it may turn freely round. It is to be fixed on the centre of a small ivory circle C, of the thickness of a counter, which is placed on the object-glass D, and painted black on the side next it. This circle must be kept fast by a circular rim of pasteboard, that the needle may not rise off its pivot after the same manner as in the compass: this tube will thus become a compass sufficiently transparent to show the motions of the needle. The eye-glass serves more clearly to distinguish the direction of the needle, and the glass at the other end merely to give the tube the appearance of a common perspective. The needle in this tube when placed over, and at a *small distance from* a magnet, or any machine in

which it is contained, will necessarily place itself in a position directed by that magnet, and, consequently, show where the north and south pole of it is placed, the north end of the needle constantly pointing to the south end of the magnet. You must observe, however, that the attracting power must not be very far distant from the needle, especially if it be small, as in that case its influence extends but to a short distance. This tube may be differently constructed, by placing the needle in a perpendicular direction on a small axis of iron, on which it must turn quite freely, between two plates of brass placed on each side the tube: the two ends of the needle should be in exact equilibrium.

Communicative Money.

Take a crown-piece, and bore a hole in the side of it, in which place a large needle strongly touched with a magnet, then close the hole with a small piece of pewter that it may not be perceived. Now, the needle in the "magnetic perspective" in the above article, when it is brought near to this piece of money, will fix itself in a direction correspondent to the needle in that piece. Desire any person to lend you a crown-piece, which you dexterously change for one that you have prepared as above, which give to another person, and leave him at liberty either to put it privately in a snuff-box or not; he is then to place the box on a table, and you are to tell him, by means of your glass, if the crown is in the box or not. Then bringing your perspective close to the box, you will know, by the motion of the needle, whether it be there or not; for, as the needle in the perspective will always keep to the north of itself, if you do not perceive it has any motion, you may conclude the crown is not in the box. It may happen, however, that the wire in the crown may be placed to the north, in which case you will be deceived. Therefore, to be sure of success, when you

find the needle in the perspective remain stationary, you may make some pretence to desire the person to move the box into another position, by which you will certainly know if the crown-piece be there or not.

A Galvanized Tongue.

On coating the point of the tongue with tin foil, and its middle part with gold or silver leaf, a sourish taste is produced.

Powerful Batteries.

Sir H. Davy's great voltaic battery consisted of two thousand double plates of copper and zinc of four inches square.

Each plate of Mr. Children's large galvanic battery consists of thirty-two square inches, and produces intense heat. Iron was instantaneously converted by it to blister steel, and diamond powder disappeared.

Sir Isaac Newton's Magnet.

The smallest natural magnets generally possess the greatest proportion of attractive power. The magnet worn by Sir Isaac Newton, in his ring, weighed only three grains, yet was able to take up 746 grains, or nearly 250 times its own weight; whereas, magnets weighing above two pounds, seldom lift more than five or six times their own weight.

Wedgewood's Black Ware.

Wedgewood's black ware, which is made of basalt, attracts the magnet strongly.

To produce a Carmine-Red Flame.

The flame of the spirit of wine may be coloured by the addition of various bodies which the spirit holds in solution. The flame of alcohol is tinged red in the following manner :—Put into a small iron ladle one part of muriate of strontia, and pour over it three or four of alcohol, then set it on fire with a candle, or a piece of burning paper, it will burn with a bright carmine-red flame, especially if the mixture be heated, by holding the ladle over the flame of a lamp or candle to cause the alcohol to boil rapidly.

To produce an Orange-coloured Flame.

Put muriate of lime, deprived of its water of crystallization into an iron ladle, cover it with spirits of wine, and cause it to burn in the manner stated.

To produce an Emerald-Green Flame.

Cause alcohol to burn in a ladle upon nitrate of copper.

Preparation of Muriate of Lime.

Dissolve common marble in muriatic acid, and evaporate the solution to perfect dryness.

Garnerin's Balloon.

The hydrogen of Garnerin's balloon weighed forty-four pounds, which,

being thirteen times lighter than atmospheric air, would, of course, float	572 pounds
Suppose the balloon altogether to weigh ..... 112 pounds	
Add for the passengers, &c. 400	512
Weight remaining to work upon	60 pounds

Coal-Gas Balloons.

Mr. Green has the merit of being the first person who tried experiments on the buoyant properties of coal gas. In some of his preliminary trials, he ascertained that the ascensive force of a small balloon, three feet in diameter, was equal to eleven ounces, and when filled in the old way with hydrogen gas not more than fifteen ounces.

Greatest Elevation attained.

Guy Lussac in a balloon reached the height of 23,040 feet, or 4 miles 1920 feet.

Gas.

This term is applied to all permanently elastic fluids of an aërial form except common atmospheric air.

Barometric Changes.

The mercury in the barometer is seldom to be seen lower than 28 inches, or higher than 30½; it indicates as follows:—

31 inches ..... Very dry weather, hard frost.
30½ ..... Settled fair, settled frost.
30 ..... Fair, frost.
29½ ..... Changeable.
29 ..... Rain, snow.
28½ ..... Much rain, much snow.
28 ..... Stormy weather.

In January, 1822, the mercury fell to 28·10, which was said to have been the lowest ever remarked in England. By the fall, a pressure equal to 2000 lbs. was removed from each person's body, yet probably no individual was at the time conscious of it. The maximum height of the mercurial column is about nine o'clock A.M., the mean at twelve, and the minimum at three P.M. If the column rise from nine A.M. to three P.M. it indicates fine weather; if it fall during that interval rain may be expected.

Simple Method of Cooling Wine, &c.

Dip a cloth into cold water, and slightly wring the water from it, wrap it round the bottle, which hang up in the sun; the water in the cloth is gradually converted into vapour, to form which the liquor in the bottle is deprived of its latent fire.

Exposition of a Paradox.

It is a vulgar paradox, "that when water is boiling in a vessel the bottom is cool, but the moment it ceases to boil the bottom becomes hotter." The whole of the paradox appears to be founded on an error of sense. When a person applies his finger to the vessel, though he applies it for a considerable time, it is not heated more than he can endure, for the blood in the course of its circulation loses some of its heat before it arrives at the extremities; and till the blood

in the extremities is heated to the same degree with that of the heart we feel no pain from burning, but as soon as this is effected the least degree of heat becomes painful. When the finger is first applied to the bottom of the vessel, after it is taken off the fire, the heat is endured for these reasons. When the boiling ceases, it is natural to take the same finger (for, having dirtied one, people seldom choose to take another), and that finger being already heated almost as much as it could bear, now finds the heat at the bottom of the vessel exquisitely painful.

The Intermitting Fountain.

The following account gives the construction of the intermitting fountain, *Fig* 9.

A B C is a globe of glass (or if any other substance) pierced with several holes, to which are adapted the little tubes *n*, *o*, *r*, *s*, and traversed in the direction of its vertical axis by a tube C Z, whose upper part *i* is raised to within a small distance of the summit *e*, and whose lower part is fitted exactly into the hollow cylinder S D, fixed at the bottom of a cistern M T. The lower part of this cylinder is hollowed laterally at *u*, so that there is a free communication between the air contained in the vessel A B C, and the exterior air. The cistern M T is pierced with a little hole, by means of which it communicates with a reservoir K placed below it. When we would make use of this fountain, we must take the tube C Z from the cylinder S D, and then invert it in order to pour through it water into the vessel A B C, until the latter is full. The tube is then to be turned again, and replaced in the cylinder S D: at this moment the exterior air which enters freely by the cavity *u*, will exert its pressure upon the surface *a b* of the liquid; it will also act with a force, equal as to sense, upon the water which tends to spout forth from the tubes *n*, *o*, *r*, *s*, in such manner,

that in this respect the water is in equilibrium between the two forces of the air; it will therefore flow from the little tubes in virtue of its proper weight. In proportion as this water falls into the cistern M T, a part will pass through the hole with which its bottom is pierced; but, as it receives more than it thus loses, there will be a term when the cavity *u* will be so stopped up with water that the air can no longer enter into the vessel A B C. Nevertheless, the water will continue to run out for a short interval, while the interior air dilates itself, and its spring becomes so weakened that this force, together with the weight of the water, are in equilibrio with the pressure of the air at the orifices of the tubes *n*, *o*, *r*, *s*; then will the discharge, which is made by these tubes, stop at once. But the cistern M T continuing to empty itself, it will soon happen that the cavity *u* becomes open again, and that the air is again introduced into the vessel A B C, so that the little tubes will recommence their delivery of water. The fountain will thus flow and cease alternately, until the vessel which furnishes the water is emptied.

To cause a Green Lambent Flame to appear and alternately disappear at the Mouth of a Flask.

Put a few pieces of phosphorus of the size of a bean into a Florence flask half filled with water, and make the water boil over a lamp: when the water has boiled for a few minutes, the empty part of the flask becomes filled with dense white vapours; and when the ebullition is suffered to go on, the fumes gradually disappear, and a lambent green flame makes its appearance with an undulatory motion at the orifice of the flask, and continues as long as the water is kept boiling. When the lamp is withdrawn the phosphorescent flame gradually rushes down, and the internal surface of the vessel exhibits, in a dark place, illuminated clouds rolling over each

other. When the heat is again applied to the flask the flame re-appears, and again vanishes, and descends into the body of the vessel the moment the water ceases to boil; and these appearances may be repeated as long as any water is left in the flask.

Curious change of Colour.

Put into an ounce phial a slip of copper scraped bright, fill up the phial with liquid ammonia, and cork it air-tight. No apparent change will take place; but if the bottle be left open for some hours, and then be closed, a solution of the colour is effected, which is absolutely colourless, and turns blue on re-opening the bottle, beginning at the surface, and gradually extending downwards through the mass. Again, if this blue solution has not been too long exposed to the air, and fresh pieces of copper be put in, stopping the bottle again, the solution is deprived of all its tinge, and recovers its colour by the admission of air; and this effect may be produced repeatedly.

To shew that Water is contained in the Atmosphere in the driest Weather.

Take a tea-spoonful of dry muriate of lime, or acetate of potash, or sub-carbonate of potash, spread it in a saucer, and suffer it to be exposed to the open air for a few days, the dry salt will thus be rendered completely liquid, by the watery vapour which always exists in the atmosphere.

Natural and beautiful Barometers.

Changes in the state of the atmosphere affect, and are foreshewn by the opening and shutting of many flowers.

If the Siberian sow-thistle shuts at night the ensuing day will be fine, and if it opens it will be cloudy and rainy; if the African marigold continue shut after seven o'clock in the morning rain is near at hand; if the convolvulus arvencis, calendula fluvialis, or anagallis arvencis, red prinpernel, are fully open, they will close upon the approach of rain: the last of which, from its peculiar susceptibility, has obtained the name of the poor man's weather-glass.

Effect of the Friction of Silk on Glass.

The effect of long-continued action, where the impression in any single instant of time is altogether inappreciable, is nowhere more clearly illustrated than in the machinery for winding silk in silk mills. To change the direction of the threads, they are made to pass over the polished surface of a rod of glass, and, though the softness of silk be proverbial, it appears, that the constant sliding of a fine thread of it over the surface of a glass rod in process of time wears even that hard body into perceptible furrows; while we observe this effect, its illustration of the minute divisibility of matter appears very striking. What must be the magnitude of the particles removed at once, when the continued action of ten hours per day, for half a year, produces a furrow not exceeding one ten thousandth part of a square inch in area?

Beautiful Experiment.

Mix a grain or two of potassium with a like quantity of sodium, by rubbing them together with the

point of a knife. The mixture will take place quietly; but, if the alloy of these two bodies be brought into contact with a globule of quicksilver, the compound when agitated instantly bursts into a most beautiful flame, and burns vividly.

To shew that the White of Eggs contain an Alkali.

Add to half a wine-glass full of tincture of red cabbage a small quantity of the white of an egg either in a liquid state, or rendered concrete by boiling. The tincture will lose its blue colour, and be changed to green, because the white of the egg contains soda.

To change a Blue Fluid to Red by the Air respired from the Lungs.

Add to two tea-spoons-full of water (in a wine-glass) a sufficient quantity of tincture of cabbage to tinge it very slightly blue, and blow through the coloured water the breath from the lungs by means of a quill or tobacco-pipe dipping into the fluid. The bubbles of air expired whilst passing through the water will speedily produce the reddening effect, because the air respired from the lungs contains carbonic acid.

Preparation of Tincture of Cabbage.

Tincture of cabbage is very liable to spoil; it soon undergoes a kind of putrefaction which destroys its colour. It is obtained by cutting fresh leaves of the red cabbage into small pieces, and pouring over it boiling hot distilled water, and suffering the whole to macerate for a few hours. The clean fluid being then decanted, and mixed with one-eighth of its bulk of spirit of wine, is fit for use.

The cabbage leaves may be preserved for many years, by drying them in a warm place, at a temperature of about 120° F., having previously cut them into small pieces.

To prepare the test liquor from the dry leaves, let them be digested in distilled water, to which a minute portion of sulphuric acid has been added, which will produce a red tincture; then let the acid be neutralized by marble powder, the red colour will vanish, and the tincture become blue. This being done, suffer the mixture to become clear by subsidence, or filter it; and, lastly, mingle it with one-eighth of its bulk of spirit of wine.

Expansive Force of Freezing Water.

Colonel E. Williams, of the Royal Artillery, when at Quebec, made many experiments on the expansive force of freezing water. He filled all sizes of iron bomb-shells with water, then plugged the furze-hole close up, and exposed them to the strong freezing air of the winter in that climate, sometimes driving in the iron plugs as hard as possible with a sledge hammer; and yet, though they weighed near three pounds, they were always forced out by a sudden expansion of the water in the act of freezing, like a ball impelled by gunpowder, sometimes to the distance of between 400 and 500 feet; and when the plugs were screwed in, or furnished with hooks or barbs, by which to lay hold of the inside of the shell, so that they could not possibly be forced out, in that case the shell will always split in two, though its thickness of metal was about an inch and three quarters. It is farther remarkable, that through the circular crack, round about the shells where they burst, there stood out a thin film, or sheet of ice like a fin; and in the cases where the plugs were projected by freezing water, there suddenly issued from the furze-hole a bolt of ice of the same diame-

ter, and stood over it sometimes to the height of eight inches and a half. Hence, we need not be surprised that excessive frost should cause the ice to split rocks and other solid substances.

Chances of obtaining a Sum of Money.

Suppose, in order to obtain £90, two events must happen, the first of which has three chances to happen and two to fail, and the second has four chances to happen and five to fail.

The probability of the first happening is $\frac{3}{5}$, the probability of the second happening is $\frac{4}{9}$, now, these multiplied, are $\frac{12}{45}$ or $\frac{4}{15}$, and this multiplied into the sum expected, or £90, is equal to $£\frac{360}{15}$, or £24, which is the value of the expectation.

To find the Probability of taking in a Trump at Three-Card Loo.

As one trump is turned up there can be but twelve in fifty-one cards, therefore, the probability of taking the three cards out of the remaining stock of thirty-nine deducted from unity, will give the answer, being $\frac{39}{51} : \frac{38}{50} : \frac{37}{49} - 1 = \frac{79116}{124950}$, or nearly nine to seven in favour of a trump; and by similar reasoning the probabilities may be found for any other number of cards.

Chances at Hazard.

Hazard is played with two dice. He who throws is called the *caster*, and whoever sets against him, or stakes money against him, is called the *setter*. The points called mains are 5, 6, 7, 8, and 9, either of which he may call before he throws; and as there *are several points* allotted in the game for the caster

either to win or lose in the *first throw*, called a or a *crab*, these points are placed in the follo order, both for and against him, that by taking chances from the table for the points to *win*, and points to *lose*, the probability may be seen of e *main* being determined by the *first throw*.

Mains.	*Points to Nick or Win First Throw.*	*Points to Crab or lose First Throw.*	*Probability of being decide or off the First Throw.*
5	 5	2, 3, 11, or 12	$\frac{18}{36}$, or 13 to 5 against it.
6	6 or 12	2, 3, .. or 11	$\frac{11}{36}$, or 25 to 11 against it.
8	8 or 12	2, 3, .. or 12	$\frac{12}{36}$, or 2 to 1 against it.
9	 9	2, 3, .. or 12	$\frac{18}{36}$, or 13 to 5 against it.

If the game is not determined the first throw, whatever chance or number of points the caster may throw, such becomes his own chance, and the main will be the setter's chance. He then throws on till one or the other comes up; if his own comes up first he wins, but if the setter's chance comes up first he loses, and the setter wins.

Catoptric Cistula.

The catoptric cistula is a machine by which small bodies are represented extremely large, near ones extremely wide, and many other agreeable phenomena, by means of mirrors disposed in a kind of chest, according to the arrangement of which objects are deformed, magnified, multiplied, &c. &c. The description of the two following will be sufficient to shew how many more may be made.

Catoptric Cistula to represent several different Scenes of Objects when viewed at different Holes.

Provide a polygonous box, (see *Fig.* 10) of the figure of the multilateral prism A B C D E F, and divide its cavity by diagonal planes E B, F C, D A, intersecting each other at the centre into as many triangular cells as the chest has sides. Line these diagonal planes with plane mirrors: in the lateral planes make round holes, through which the eye may see within the cells of the box. The holes are to be covered with plain glasses ground within side, but not polished, to prevent the objects in the cells from appearing too distinctly. In each cell are to be placed the different objects whose images are to be exhibited, then covering up the top of the box with a thin transparent membrane or parchment to admit the light, the machine is complete.

Every hole will afford a new scene; according to the different angles the mirrors make with each other the representation will be different. If they be all an angle greater than the right one, the images will be monstrous, &c.

The parchment that covers the box may be made pellucid, by washing it several times in a very clear ley, then in pure water, and bracing it tight, and exposing it to dry. If it be wished to throw any colour on the objects, it may be done by colouring the parchment; for green, verdigrease ground in vinegar; for red, decoction of Brazil wood, &c. &c. The parchment should be varnished to make it more transparent.

Catoptric Cistula to represent the Objects within it enormously multiplied, and diffused through a vast Space.

Make a box like the above, but without dividing the cavity into cells (see *Fig.* 11). Line the lateral

planes C B H I, B H L A, A L M F, &c., with plane mirrors, and at the apertures pare off the tin and quicksilver that the eye may see through: place what objects you prefer in the bottom M I, *e g*.

Here the eye looking through the aperture *h i* will see each object placed at the bottom prodigiously multiplied, and removed at equal distances from each other.

Electrical Illumination.

To illuminate eggs by electricity, it is merely necessary to get a mahogany stand so constructed as to hold three eggs at a greater or smaller distance, according to the position of two sliding pieces of wire. A chain is then placed at the bottom in such a manner as to touch the lowest egg with one end, and with its other the outside coating of a charged jar. The sliding wire at top is made to touch the upper egg, and the distance of the eggs asunder should not exceed the quarter or eighth part of an inch. The electricity being, by means of the charging rod, sent down the ball and wire, will, in a darkened room, render the eggs luminous and transparent.

Prodigious Report.

Stick a candle-bomb in the tallow of a candle, so that the globular part shall be in contact with the flame. In a few seconds it will burst with a loud report, scattering the glass in every direction, and extinguishing the candle.

Arithmetical Paradox.

Two Arabians sat down to dinner, one had five loaves, the other three; a stranger passing by, desired

permission to eat with them, which they agreed to: the stranger dined, laid down eight pieces of money, and departed; the proprietor of the five loaves took up five pieces, and left three for the other, who objected, and insisted for one half. The cause came before Ali, (the magistrate,) who gave the following judgment:—let the owner of the five loaves have seven pieces of money; and the owner of the three loaves one.—Query, the justice of this sentence?

Ali's sentence was just; for, suppose the loaves to be divided into three equal parts, making twenty-four equal parts in all the eight loaves, and each person to eat an equal or eight parts; therefore, the stranger had seven parts of the person who contributed five loaves, or fifteen parts, and only one of him who contributed only three loaves, which make nine parts.

Cheap Hygrometer.

A very ingenious apparatus of this kind, may be made to consist of a short piece of cord, or cat-gut, from four to ten inches, suspended by a hook over a horizontal board; to the lower end of the cord is fixed a horizontal index, having a circular graduated scale on the board. As the cord attracts moisture, or the contrary, it twists or untwists, and thereby turns the index. On this principle, the Dutch toys, called weather-houses, are made; one end of the index supports a small image of a man, and the other that of a woman; the former appears, or is brought out in wet weather, and the latter in fair weather.

Crystallization of Tin.

Melt four ounces of tin in a clean crucible; when in a liquid state, immerse a thick iron wire in it, take it off the fire, and let it cool until a hardened covering be formed on the top, of the thickness of a half-penny. Now, withdraw the wire, and pour out

through the aperture all the fluid tin beneath. When the crucible is quite cold, break it, and take out the hardened covering; it will be found in a crystallized state, and will exhibit a very beautiful appearance.

Very loud Report.

Put about a grain of fulminating gold on the end of a table knife, and hold it over a candle; an immediate and very loud explosion will take place.

Explosion of Detonating Silver.

Throw two grains of detonating siver into a gallipot containing one drachm of nitric acid, explosion and inflammation will take place, and the acid will be thrown about.

On Sounds excited in Hydrogen Gas.

As the intensity of sound is diminished by the rarefication of the medium in which it is produced, it might have been expected that the sound in hydrogen gas would be feebler than when produced in atmospheric air in similar circumstances. Mr. Leslie, however, has found the difference to be actually much greater. Having placed within a receiver of an air-pump, a small piece of clock-work, by which a bell was struck every half minute, the air was rarefied, and after the re-action had been carried the length of one hundred times, hydrogen gas was introduced. The sound, however, so far from being augmented, was, at least, as feeble as in atmospheric air of that extreme rarity, and decidedly much feebler than when formed in air of its own density, or rarefied ten times. Mr. Leslie likewise observed the very curious fact, that the mixture of hydrogen gas with atmospheric air, has a predominant influence in blunting or stifling sound. When one half of the volume of

atmospheric air is extracted, and hydrogen gas admitted to fill up the vacant space, the sound will now become scarcely audible; an effect which he ascribes to a want of intimate combination between the gases, which causes the pulsatory impressions to be dissipated before the sound is originally formed.

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Inflation of Rarefied-Air Balloons.

With regard to the rarefied-air balloons, the method of filling them is by means of a scaffold, the breadth of which is at least two-thirds of the diameter of the machine, and elevated about six or eight feet from the ground. From the middle of it descends a well, rising about two or three feet above, and reaching to the ground, furnished with a door, through which the fire in the well is supplied with fuel. The well should be constructed of brick, and its diameter should be somewhat less than that of the machine. On each side of the scaffold are erected two masts, each of which is fixed by ropes, and has a pulley at the top. The machine is to be placed on the scaffold, with its neck round the aperture of the well. The rope passing over the pulleys of the two masts, serves to lift the balloon about fifteen feet above the scaffold; and it is kept steady and held down whilst filling, by ropes passing through loops or holes about its equator. These ropes may easily be disengaged from the machine, by slipping them through the loops when it is able to sustain itself. The proper combustibles to be lighted in the well, are those which burn quick and clear, rather than such as produce much smoke, because it is *hot air* and not smoke that is required. Small wood and chopped straw are very fit for this purpose. As the current of hot air ascends the machine will dilate, and lift itself above the scaffold and gallery which was covered by it. The passengers, fuel, instruments, &c. are then placed in the gallery. When the machine makes efforts to ascend, its aperture must be brought, by means of the ropes annexed

to it, towards the side of the well, a little abov scaffold; the fire-place is then suspended in it fire lighted in the grate, and the lateral ropes l slipped off the machine is let go.

To cause Bubbles of Gas to issue from Water, wh take Fire with a Brilliant Flame.

Put a piece of phosphuret of lime, of the size o pea, into a wine-glass, half filled with water; t phosphuret will fall to pieces, and bubbles of gas wi rise up to the surface of the water, which take fir with a brilliant flame and snapping noise, when the come into contact with the air: each bubble of ga as it explodes, if the air be calm, is succeeded by a horizontal ring of dense white smoke, which mounts up to the cieling with an undulatory motion, and gradually enlarges in diameter as it ascends.

The residue of the phosphuret of lime, when taken out of the water and suffered to dry, inflames, by pouring on it a little muriatic acid.

The bottle containing the phosphuret of lime should never be left open, for the contact of air soon renders it unfit for use.

The Thaumatrope—an amusing Toy.

In a round box are contained several cards, each suspended by a piece of bobbin at either side. There is *part* of a figure or object represented on one side of the card, and the remainder on the other. For example: we have the head of a watchman on the obverse of one, and the empty watch-box on the reverse; by twirling the bobbins, and consequently spinning the card, the head and box fit together, and we see a complete guardian of the night.

Then there are some choice *jeux d'esprit*. There is on the obverse of one card a thing like a well-worn *bundle of birch*, bu by twirling the bobbins we pro-

duce a shower of fresh leaves, and these leaves falling upon that bundle produce the striking likeness of a *tree.*

The optical principle on which this machine is constructed, is the duration of an impression on the eye, after the object producing it has been withdrawn, and which is said to last about a second.

Detonating Powder.

Mix together ten grains of powdered charcoal with ten grains of powdered nitrate of silver, and wrap the powder in a piece of paper; if it then be placed on the hearth, and struck with a warm hammer, a smart explosion will take place, and the metal will be reduced.

Cheap and useful Apparatus.

For many of the experiments mentioned in this book, useful apparatus may be made with a common Florence oil-flask, divided into two parts by means of a thread, previously dipped in oil of turpentine, tied round the middle and ignited; the upper part will make a good funnel, the other will contain chemical ingredients, which may require to be held over a flame.

Easy method of ascertaining the illuminating power of Candles, Lamps, or Gas-lights, so as to ascertain the real and comparative value of different kinds of lights.

Fasten a sheet of white paper against the wall of a room, and place two lights intended to be compared, so that the rays of light from each fall with nearly the same angle of incidence upon the middle of the paper. In this situation, if a book or other object be *held to intercept* part of the light which would have

fallen on the paper, the two shadows may be made to appear, as at *Fig.* 33, where A represents the surface illuminated by one of the lights only; B the surface illuminated by the other light; C the perfect shadow, from which both lights are excluded. It will easily be understood that the lights about D and E, near the angle F, will fall with equal incidences when the double shadow is made to occupy the middle of the paper; and consequently, if one or both of the lights be removed directly from or towards the paper, as the appearances may require; until the two shadows at E and D have the same intensity, the quantity of light emitted by each, will be as the squares of the distances from the paper.

By experiments of this kind, many useful particulars may be shown; for, since the cost and duration of candles, and the consumption of oil in lamps, are easily ascertainable, it may be shown whether more or less light is obtained at the same expense during a given time, by burning a number of small candles, instead of one or more of greater thickness. It will, therefore, be easy to compare the power of different kinds of lamps, or candles, or gas-lights, so as to determine the relative cost of each particular kind of the combustible substance employed for furnishing light: for example,—if a candle and a gas-burner supplying coal-gas, adjusted by a stop-cock, if more or less be required, and the candle is carefully snuffed to produce the most regular and greatest quantity of light. The size of the flame, in experiments of this kind, of course becomes unnecessary, and will vary very much with the quantity of the coal-gas. The bulk of the gas consumed, and the quantity of the tallow used, by weighing the candle before and after the experiment, furnish the data for ascertaining the relative costs of tallow and gas-light, when compared with each other.

The Portable Gas Lamp.

Mr. D. Gordon, of Edinburgh, was the inventor of the portable gas-lamp, in which carburetted hydrogen gas may be condensed, and used as a moveable light. There is one application of the portable gas-lamp to which a high valve is attached. By an extreme diminution of the aperture, the flame can be rendered so small (in which case it is reduced to a blue colour) as to give no perceptible light, and to occasion almost no consumption of gas. In this state the lamp may be used in bed-rooms; and the imperceptible flame may at any time be expanded into the most brilliant light, by turning the cock, by means of a metallic rod terminating near the bed. *Fig.* 12 represents one of the portable gas-lamps, six inches in diameter, and nine inches high, exclusive of the hemispherical ends and burner at the top, which, when filled with coal-gas condensed twenty-five times, will supply a lamp equal to five candles, six to the pound, for six hours; and when filled with vegetable oil-gas, will burn for about twelve hours.

Gas lights require no trimming, snuffing, or any trouble whatever, except merely turning a cock, by which a flame of any size may be formed.

To imitate the beautiful Appearance of the Sea when luminous.

Wet a lump of fine loaf sugar with phosphorized ether, and throw it into a basin of water; the surface of water will become luminous in the dark, and, by gently blowing upon it, phosphorescent undulations will be formed, which illuminate the air above the fluid to a considerable distance.

In winter it will be necessary to render the water blood-warm. If the phosphorized ether be applied to the hand, or other warm objects (which may be done with safety,) it renders them phosphorescent in the *dark.*

Production of Light by Breaking Glass Balls filled with Oxygen.

This very curious and important experiment consists in breaking a ball of glass filled with oxygen gas, and placed in the receiver of an air-pump, in which as perfect a vacuum as possible has been formed. The effect of this is to produce a brilliant light in a dark apartment.

Singular Explosions of Fulminating Mercury, and Fulminating Silver.

During a lecture in the laboratory of Yale College, about 100 or 150 grains of fulminating mercury lay on a stool, and were covered with a glass receiver, of about five or six quarts capacity. A small quantity of the same powder, at a distance of a few feet, was merely flashed by a coal of fire, but without explosion. In a manner not easily understood, the whole powder under the glass receiver instantly exploded with a dreadful report; but, what was particularly remarkable, the glass was merely lifted up a little, and was shattered by its fall, *while the stool, made of fir plank, an inch and a half thick, on which the powder lay, had* a hole blown quite through it, almost as large as the *palm of the hand.* The whole effect of the explosion was confined to the stool, every thing round having remained uninjured.

An effect almost equally singular, took place lately in the same laboratory, with some fulminating silver on the point of a knife, which was about to be put upon a plate of copper, connected with one pole of a galvanic battery in active operation. The other pole was not touched by the experimenter, but, probably by the influence conveyed through the floor of the room, the powder exploded the moment the knife touched the plate of copper. *The knife blade was broken in two, and one half of it thrown to a distance among the audience.*

Heat Developed in Solutions Crystallized by Exposure to the Air.

When 51 parts of sulphate of soda, and 49 parts of water are placed in a phial, and the stopper removed in a temperature under 50°, the crystallization of the mass takes place, and there is a rise of temperature equal to 24° of Fahrenheit. When the carbonate of soda is used, small crystals or stars are abundantly precipitated, and the temperature rises 14°. From a series of experiments made in this way, it is concluded, that the latent heat of the water of crystallization is in both cases, the cause of increase of temperature.

Substitute for Harrowgate Water.

Into an oil flask pour three or four table-spoonsfull of a solution of sulphuret of potash, and add to it, a small portion of diluted muriatic acid; insert immediately into the orifice of the flask, a cork, having a piece of tobacco-pipe passed through it, and fixed air-tight in a bladder previously moistened and collapsed: in a short time the bladder will be filled with sulphuretted hydrogen gas. Now fill another flask half-full of water; remove the bladder, and in a similar manner apply the cock to the orifice of this flask; press the bladder, at the same time agitating the fluid, which will become impregnated with the gas, and will answer the same purpose as Harrowgate water for the detection of wines.

Another Sympathetic Ink.

Make a solution of super-acetate of lead, in a wine-glassful of water, and write with it on paper, the characters will be invisible. Hold the paper, whilst the letters are moist, over a tea-cup containing Harrowgate water, or *the above substitute*, and they will appear of a brilliant silver-like lustre.

Reflected Heat.

Buffon kindled wood by reflection from mirrors, at a distance of 210 feet.

A drop of water rolls about on a red hot iron without evaporation, because its surface becomes so highly polished as to reflect all the heat. If the heat be less, the water penetrates the pores of the oxidated iron, and losing its polish, is evaporated.

Concentrated Cold.

A piece of frozen quicksilver the size of a walnut, dropped into a tumbler of warm water, occasions its instant congelation, accompanied with the fracture of the glass.

Friction.

Sir H. Davy melted two pieces of ice by their mutual friction, in a room cooled below the freezing temperature.

Extreme Tenuity.

The thinnest substance ever observed is the aqueous film of the soap bubble previous to its bursting; yet it is capable of reflecting a faint image of a candle, or the sun.

On the Discoloration and Porosity of Coral Ornaments, and the Method of preventing those defects.

It has been long known, that necklaces, bracelets, and ear-rings of coral, undergo, after being worn, a very remarkable change, and become extremely white and porous. Jewellers have no other remedy

for this deterioration, than to remove the upper stratum of coral, till they come to a depth where no alteration had been produced.

This change has been ascribed to the action of air and of light; but this was found by experiment, not to have been the case; and a discoloration never took place, unless when the coral had actually been worn as an ornament, in which case it has sometimes been completely whitened, when used only two or three times upon the naked skin, and in heated apartments. M. Virey, therefore, very properly ascribes the discoloration and porosity of the coral to the action of a particular acid which exists in the moisture of the body. According to the analysis of Thenard the acetic, according to Berzelius, the lactic, and according to Berthollet the phosphoric acid, is found in it under particular circumstances.

In order to prevent the deterioration of coral when used for the purposes of jewellery, it will be sufficient to impregnate it with a fat body, which will defend it from the immediate action of weak acids; and, for this purpose the coral should be digested in warm oil, or melted wax, which will enable it to resist the action of the acid to which it is exposed.

Preparation of Phosphorized Ether.

Phosphorized ether is prepared, by suffering sulphuric ether to stand, for some weeks, over a considerable quantity of phosphorus in a well-stopped phial.

A new method of Bleaching Sponge for the Toilet.

To bleach sponge and render it perfectly white, it is necessary to soak it in cold water, but if it does not become soft, it must be immersed in boiling water, but this should, if possible, be avoided, for it causes it to shrink and become hard, and so tough as to prevent it being bleached; but if the sponge is soaked

in cold water, and the water be changed three or four times a day, the sponge being pressed perfectly dry: at the expiration of five or six days, it will be ready for bleaching.

If the sponge, as is frequently the case, should contain small pieces of chalk or shells, which cannot be got out without tearing it; the sponge must be soaked for twenty-four hours in muriatic acid, with twenty parts of water, which will cause an effervescence to take place, when the shells and chalk will become perfectly dissolved. After that it must be carefully washed in fresh water, and immersed in a weak solution of sulphuric acid; which immersion should continue about eight days, occasionally being pressed dry, and thoroughly washed. After being perfectly washed and cleansed, it should be sprinkled with rose water to give it a pleasant smell, which completes the process.

Experiment to prove the Dilatability of Metals by Heat.

Take a plate of copper hollowed into the form of a ring, and a globe of the same metal, the diameter of which is precisely equal to that of the opening of the ring, so that when the latter is at the ordinary temperature, the globe will pass through its opening without having a perceptible interstice: afterwards, when the globe is heated, it will be sustained by the ring, in whatever position it is placed upon it.

Another Experiment to prove the Dilatability of Glass.

Take a glass tube, of a small diameter, terminated by a ball of the size of an orange, fill the ball and a part of the tube with a coloured liquor, and mark on the tube the height at which it stands; immerse the ball in a vessel full of water near boiling, and then draw it out again: at the moment of the immersion the liquor in the tube descends precipitately by

a considerable quantity; but it rises again a little higher than the mark made upon the tube, as soon as the ball is drawn out of the hot water. In this experiment the heat, which is communicated at first to the glass, dilates the parts, which augments the capacity of the ball, and causes the liquor to descend; the ball being afterwards taken out of the hot water, and again placed in contact with the air, counteracts, and the liquor, which has previously acquired a small quantity of heat, rises a little above its first level.

Brilliant Electrical Star.

If a plate of tin be cut into the form of a star, and be supported on its centre by a wire projecting from the prime conductor, as soon as the wheel of the machine is turned, and this apparatus electrified, a flame will appear at the extremity of every angle of the star, which will be very beautiful; and if the star be made to turn swiftly on its centre, an entire circle of fire will be seen in the dark. This experiment will appear very surprising to persons unacquainted with electricity; if the operator now and then privately touch the prime conductor, which may easily be managed as the experiment is performed in the dark; for by this means he may command the appearance or disappearance of the star or circle of fire, at pleasure.

Electrical Aurora Borealis and Falling Stars.

If electricity be passed through an exhausted receiver or tube gradually, it assumes the appearance of the northern lights; but, if a considerable electrical accumulation be suddenly transmitted, it will pass through the receiver with all the straightness and brilliance of a falling star. If the receiver is six inches diameter, and fourteen or sixteen inches high, the full charge of a moderate sized jar is necessary to *produce this effect*, and it occurs most readily when

the receiver is but moderately exhausted, so that the rarefied air it contains may have some degree of resistance. The artificial imitation of these two phenomena, therefore, require the same conditions for their production as appear to obtain in nature; for the Aurora occurs in the highest parts of the atmosphere, where the air is most rarefied; and the most accurate imitation of its appearance is obtained in the most perfectly exhausted receiver; falling stars take place much lower, where the air has more density, and to imitate them, it is necessary to employ a medium that opposes some resistance.

Method of making a Cheap Aromatic Vinegar, for purifying large Buildings, or Manufactories, &c.

Take of common vinegar any quantity, mix a sufficient quantity of powdered chalk, or common whiting with it, to destroy the acidity; then let the white matter subside, and pour off the insipid supernatant liquor; afterwards let the white powder be dried, either in the open air, or by a fire. When it is dry, pour upon it sulphuric acid, as long as white acid fumes continue to ascend. Stone vessels are most proper to be used on this occasion, as the acid will not act upon them. This product is the acetic acid known in the shops by the name of aromatic vinegar. The simplicity and cheapness of this process, point it out as a very useful and commodious one for purifying prisons, hospitals, ships, and houses, where contagion is presumed or suspected; the white acid fumes diffusing themselves quickly round.

Artificial Cold.

Spirit of wine, æther, &c. mixed in certain proportions with snow, afford temperatures as low as those produced by sea salt.

To Silver Copper or Brass.

First clean the article intended to be silvered, by means of a little dilute nitric acid, or by scouring it with a mixture of common salt and alum. When it is perfectly bright, moisten a little of the powder known in commerce by the name of *silvering powder*, with water, and rub it for some time on the perfectly clean surface of the copper, or brass, which will become covered with a coat of metallic silver. It may afterwards be polished with a soft leather.

Preparation of Fulminating Gold.

Dissolve pure gold in nitro-muriatic acid to saturation, dilute the solution with four times its bulk of distilled water, and add to it gradually, liquid ammonia, till it ceases to occasion any precipitate; separate by means of a filter the yellow powder that will be thus produced, wash it well in water and let it dry.

To make Gold Powder, for Gilding Silver without Heat.

Dip linen rags into a concentrated solution of muriate of gold; suffer the rags to dry, and then set them on fire. The gold with which they are impregnated, becomes thus reduced to the metallic state, and mixes with the charcoal of the rags. To use this powder, (which therefore consists of finely divided metallic gold and charcoal), take a soft sound cork, moisten it with a little water, and dip it into the powder, to cause part of it to adhere to the cork, and then rub it forcibly, by means of the cork, on the surface of the silver, which should be perfectly clean and polished. The silver will become covered with an extremely thin coating of metallic gold, the colour and brilliancy of which may be heightened by burnishing.

To boil Water over the surface of Ice.

Into a cylindrical glass tube, eight or ten inches long, and half an inch in diameter, pour water, sufficient to occupy more than half an inch of it; freeze the water into a solid mass of ice, by surrounding it with a freezing mixture; (*see p.* 24). Then fill the tube with cold water within one inch of the top, and surround the lower part, which contains the ice, with flannel redoubled around it. This being done, hold the tube, inclined at an angle of about 45° over the flame of a spirit lamp, so that the portion of the water in the upper part of the tube only may be heated, taking care to hold the tube in the hand, by that part of it which is wrapped up in flannel. When the surface of the water boils, the heat may gradually be applied, nearer and nearer, towards the lower part of the tube; and thus the water may be made to boil violently within half an inch of the surface of the ice, without melting any notable portion of it.

Lacker for Brass Work.

To a pint of spirit of wine, put one ounce of turmeric powder, two drachms of the best annatto, and two drachms of saffron; let it stand ten days, shaking the bottle often, and filter through coarse muslin into a clean bottle; add then, three ounces of clean seed lac, and shake the bottle often for fourteen days. The brass must be first warmed so as to heat the hand, and the varnish then applied with a brush. This varnish gives the brass rails of desks, &c., a beautiful appearance.

Bleaching Straw.

The customary mode of bleaching straw for ornamental use, has been to stove it in a cask with burning

brimstone; but there is a readier method, if judiciously applied: take a solution of muriatic acid, and saturate it with potash until the effervescence subsides. Dip the straw in the solution. Again, the oxygenated muriate of lime, which may be had at any chemist's shop, dissolved in water, will bleach straw without the least diminution of its flexibility.

Instantaneous Light Apparatus.

The extremity of a fine platina wire is to be rolled into a spiral form, and then dipped in ammonia-muriate, or muriate of platina, until about two grains are taken up; after which it is to be heated red-hot in a spirit lamp. In this way a quantity of spongy platina is formed on the wire so minute, that if put into contact with a mixture of oxygen and hydrogen, it becomes heated, and inflames the gas as rapidly almost as if an electrical spark had passed. Such a wire as this, fixed on the jet-pipe, so that the spongy metal shall be exposed to the current of hydrogen, immediately inflames it. It happens that if an instrument of this kind has been exposed for some hours to a humid atmosphere, the inflammation does not take place readily, but in this case, if the top of the platina be touched by the finger or palm of the hand, either before or during the time that the current of hydrogen is passing out, the inflammation immediately takes place. Contact, indeed, is not necessary, for the mere approach of the hand is sufficient to elevate the temperature so much as to cause instant inflammation.

Beautiful Satin-like Crystals.

To a solution of sulphate of copper, add pure potass as long as oxide of copper falls down: or to a solution of nitrate of copper add pure lime, or lime-water. *Filter and* wash the precipitate. To this

oxide in a Florence flask, add some pure liquid ammonia, and place the flask over a lamp. The oxide will be dissolved, and the liquid will have a beautiful blue colour. Evaporate this solution gently, and it will yield beautiful crystals of a satin lustre.

Fine Star-like Crystals.

Pour three ounces of diluted nitric acid into a glass vessel, and add to it gradually two ounces of bismuth, broken by a hammer into small pieces, the metal will be attacked with great energy, and nitrate of bismuth will be formed. Crystallize the solution by a gentle heat, and preserve the crystals in a glass vessel. They possess much beauty; being radiated like fire-work stars.

An Improved Mode of Securing Oil Colours in Bladders.

Instead of drawing the neck of the wetted bladder close, (in the act of tying up, as usual) previously insert a slender cylindrical stick, and bind the bladder close around it. This, when dry, will form a tube; through which, when the stick is withdrawn, the colour may be squeezed, as wanted; and the neck be again closed by replacing the stick. This is a more cleanly mode, than the usual one, of perforating the bladder, and stopping the hole with a nail, or more commonly, leaving it open, to the prejudice of the colour.

The barrel of a small quill may be used instead of the stick, with the closed end outward; which will keep the colour secure in travelling, and when wanted to be used, the end of the quill being cut off, it may afterwards be closed by a stick.

Perpetual Engravings on Steel, and other Metals.

The merit of this invention consists in obtaining, with great facility, from *one* engraving, any required number of plates, all which are equal to the *original*, and by which millions of impressions may be produced, while, by the common process, one engraving produces only a few thousands. The process of multiplying engravings, etchings, or engine work, is as follows:—Steel blocks, or plates of sufficient size to receive the intended engraving, having their surfaces softened or decarbonated, and thereby rendered a better material for receiving all kinds of work than copper itself. After the intended engraving has been executed upon the block, it is then hardened by a new process, which prevents injury to the most delicate work. A cylinder of steel, previously softened, is then placed in the transferring press, and repeatedly passed over the engraved block, by which the engraving is transferred *in relief*, to the periphery of the cylinder; the press having a vibrating motion equalling that of the cylinder upon its periphery, by which new surfaces of the cylinder are presented, equal to the extent of the engraving. The cylinder is then hardened, and is employed to indent copper or steel plates, with engravings *identically* the same with that upon the *original* block; and this may be repeated *ad infinitum*, as the original engraving will remain, from which other cylinders may be impressed, if required. This invention promises to be of great advantage to some of our manufactures, particularly that of pottery, which may now be embellished with beautiful engravings, so as to place the successful competition of other nations at a great distance. It is also applied with great advantage to calico printing, by producing entire new patterns upon the cylinders from which they are printed. It would be superfluous to mention the beautiful highly-finished engravings which now adorn our books, rooms, &c.

Engravings of greater size than can be transferred,

are executed upon steel plates, which, when hardened, will print 200,000 perfect impressions.

It is to Messrs. Perkins, Fairman, and Heath, that the world is indebted for this valuable invention.

Metallic Casts from Engravings on Copper.

A most important discovery has lately been made, which promises to be of considerable utility in the fine arts: some very beautiful specimens of metallic plates, of a peculiar composition, have lately appeared, under the name of "cast engravings." This invention consists in taking moulds from every kind of engravings, with line, mezzotinto, aquatinta, and pouring on this mould an alloy, in a state of fusion, capable of taking the finest impressions. The obvious utility of this invention, as applicable to engravings which meet with a ready sale, and of which great numbers are required, will be incalculable; as it will wholly prevent the expense of retracing, which forms so prominent a charge in all works of an extended scale. No sooner is one cast worn out, than another may be immediately procured from the original plate, so that every impression will be a proof. Thus the works of our most celebrated artists may be handed down, *ad infinitum*, for the improvement and delight of future ages, and will afford at the same time, the greatest satisfaction to every lover of the fine arts.

To make Transparent Paintings.

The paper must be fixed in a straining frame, in order to place it between the eye and the light, when required. After tracing the design, the colours must be laid on, in the usual method of stained drawings. When the tints are got in, place the picture against the window, on a frame of glass, framed for the purpose, and begin to strengthen the shadows with Indian ink, or with colours, according as the effect

requires, laying the colours sometimes on both sides of the paper, to give greater force and depth of colour. The last touches for giving final strength to shadows and forms, are to be done with ivory-black, or lamp-black, prepared with gum-water; as there is no pigment so opake, and capable of giving strength and decision.

When the drawing is finished, and every part has got its depth of colour and brilliancy, being perfectly dry, touch very carefully with spirits of turpentine, on both sides, those parts which are to be the brightest, such as the moon and fire; and those parts requiring less brightness, only on one side. Then lay on immediately, with a pencil, a varnish, made by dissolving one ounce of Canada balsam in an equal quantity of spirits of turpentine. Be cautious with the varnish, as it is apt to spread. When the varnish is dry, tinge the flame with red lead and gamboge, slightly touching the smoke next the flame; the moon must not be tinted with colour.

Much depends on the choice of the subject; and none so admirably adapted to this species of effect, as the gloomy gothic ruin, whose antique towers and painted turrets finely contrast their dark battlements with the pale yet brilliant moon. The effect of rays passing through the ruined windows, half choked with ivy; or, of a fire among the clustering pillars and broken ornaments of the choir, round which are figures of banditti, or others, whose haggard faces catch the reflecting light, afford a peculiarity of effect not to be equalled in any other species of painting. Internal views of cathedrals also, where windows of stained glass are introduced, have a beautiful effect.

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Peculiar Characteristics of Plants.

The vital principle of plants is effected by external stimuli; hence the well known tendency of plants to lean or turn from the ordinary position of their *stems or boughs*, when in dark situations, towards

another which affords a freer access of light. The daughter of Linnæus is said to have been the earliest observer of the folding back of the trifoliate leaves of clover during the night. The leaflets of robinia and the liquorice are pendulous at night. The leaves of mimosa pudica fold themselves, and overlap one another: they thus seem composed to rest, after exposure to the stimuli of day light. This Linnæus has called the sleep of plants. But this is an ordained, and not a necessary consequence of the stimulus of light acting on vegetable fibre. Many flowers expand only when the sun shines, and close their petals at night. Though many open their blossoms in the morning, and close them at night, yet many species differ as to their hours of opening and closing, and the succession of their periodical times has been called the Horologium Floræ. But some plants only open their blossoms and exhale their sweet perfumes at night, as the oenothera, or tree-primsose, the night-blowing stock, and cereus, or cactus grandiflora. Some flowers turn towards the sun in the morning, are nearly erect at noon, and incline to the west in the evening. This property is called nutation. The fable of Clytic shews that it was noticed by the ancients.

Wheat, and probably other corn, bending with weight of grain, is observed to bend always towards the south.

Some plants are especially remarkable for their peculiar irritability. This property is well exemplified in the genus mimosa, particularly in that species well known by the name of the sensitive-plant. The leaves of dionaca muscipula, close exactly like a gin, and ensnare, and commonly squeeze to death any insect which alights on a circular process at the apex. A similar property has been observed in the leaves of the doosera, or sun-dew. The stamina of the common berberry and of the stylidium glandulosum exhibit similar sensibility.

In annual and biennial plants, says Dr. Hunter, one may observe, that before they have flowered they

resist the cold of winter, *e. g.* pinks and lychnises; but if they flower the first year, as soon as winter approaches, they generally die; if they do not flower, they will often continue in vigour three or four years. The plaintain-tree has often continued in the gardens of Holland for a hundred years; but when it has once flowered, no art, skill, or experience, can prevent its lofty stem from perishing in the year following. The cooypha, or umbrella palm-tree, remains barren for thirty-five years, growing in that time to the height of seventy feet; in the space of four months from that time, it rises thirty feet higher, puts forth its flowers, and produces fruit the same year; which done, it totally dies, both root and stem.

Steam Engine, Two Thousand Years Old.

Mr. Partington has lately exhibited a working model of a steam engine, of which the principle is more than two thousand years old. It was invented by Hero, of Syracuse; and a representation of Mr. P.'s working model may be seen at *Fig.* 13. Water must first be placed in the hollow tube *a*, and steam generated by the flame *b;* the revolving tube *a* is supported by a point at *c*, so that the steam rushing from the apertures *e e*, by its re-action produces a rotary motion.

The Infant Bacchus.

A very amusing toy is sold at the opticians under this title: it may, however, be very readily constructed for a few pence. A small barrel is to be filled with any coloured fluid, and a glass tube dipping beneath its surface, carried up to the mouth of a bacchanalian figure. A bladder is connected with the same barrel, another tube is then added, and on placing the apparatus under the receiver of an air-pump, the fluid will

be seen to rise and enter the mouth of the figur
soon as the air is withdrawn.

*To find the number of Chances to throw fourteen P
with four Dice.*

Forms of Combination.				Changes in each.	Total cha
4442	3335	....	.....	4	
6611	5522	4433	.....	6	1
5531	4451	3362	2264	12	4
6521	6431	5432	.....	24	7
Total chances to throw 14 points.....					14

The Chances of Gaining a Prize in the Lottery.

Suppose a lottery of 10,000 tickets, of £10 e
the whole value of the prizes is £100,000; let th
be only one prize of £100,000, 9999 blanks.
gives £19 : 19*s.* for a ticket; if he wins, he g
£99,980 : 15*s.*, but the chances are 9999 to 1 aga
his winning, or $\frac{1}{10000}$ expresses his probability.

Odds at Whist.

The odds for and against any particular
dealer's hand of trumps.—It is

12,211,799,222 to 1	that he does not hold	12 tru
53,326,633 to 1	.....	11
778,068 to 1	.....	10
25,457 to 1	.....	9
1,567 to 1	.....	8
163 to 1	.....	7
$26\frac{1}{2}$ to 1	.....	6
$6\frac{1}{3}$ to 1	.....	5
7 to 4	or near 9 to 5, ...	4
13 to 7	that he holds	3
$7\frac{3}{5}$ to 1	or 38 to 5.....	2
57 to 1	.....	1

It is 2 to 1 against your partner having one certain card (suppose an honour).

It is 17 to 2 against your partner having two certain cards:

But that he has one or both is about 5 to 4 in his favour.

It is 5 to 2 that your partner has one, two, or all three certain cards.

8 or 9 is about 100 or 96½ in favour of 8 with the deal: against the deal the odds are still, though small, in favour of 8.

Chances of the Dice.

The probability of throwing three aces successively on one die is $\frac{1}{6} \times \frac{1}{6} \times \frac{1}{6} = \frac{1}{216}$.

The Circle.

Kepler thought that a circle was composed of an infinite number of triangles, having their common vertex in the centre of the circle, and their infinitely small bases in the circumference.

By inscribing a rectilinear figure with a move, and circumscribing another round it, two limits are attained, one greater and the other less than the area required.

Great Weight of the Solar Inhabitants.

As the diameter of the sun (883,000 miles) is 111 times greater than that of the earth, a body of its surface would fall through 450 feet in a second of time; so that if there be any human inhabitants residing there, each individual of moderate size must weigh at least two tons.

Private Corresponding Seals.

A frame similar to those in which seals are mounted generally having been first prepared, a number of moveable circles may be made to slide within each other on one common centre. If three are employed, they should be engraved with numerals, the alphabet, and, if intended for secret writing, the third circle may be furnished with any arbitary signs that may suggest themselves. These, by means of a key, of which both the corresponding parties must possess a duplicate, may be combined to form the day of the week, month, year, &c.

It would be found very useful in preventing and detecting the mistakes which so frequently occur in the delivery of letters, if the seals in common use were provided with at least two of these revolving circles, with the day of the month and hour of the day engraved on their face, parallel to the stone. A particular part of the arms or cypher being used as an index hand, it would then show the precise hour the letter was sent, without the trouble of dating, &c.

In engraved seals where coats of arms are used it will be obvious that the seal must be larger than those generally in use, as the circles must be made to revolve round the outer extremity of the stone, and their usefulness will be considerably diminished.

Secret Writing by a knotted Silk String.

The following is a very ingenious and simple mode of secret writing.

A silk string of considerable length having been provided, it will be necessary to furnish the persons corresponding with a key or graduated guage by means of which the writing will be rendered intelligible. Having procured a duplicate or corresponding guage it may then be commenced, $\frac{1}{16}$ of an inch being allowed for the first letter, $\frac{1}{4}$ for the second, $\frac{3}{8}$ for the third, and so on, in equal proportions, through the whole alphabet.

Secret Writing by the Taste.

For writing by the *taste*, it will be necessary to immerse an equal number of peas or beads in weak solutions of alum, aloes, common salt, or any other liquid, whose taste is sufficiently pungent or aromatic, to be distinguished when dry, on applying the tongue to them for that purpose.

The Principle on which the Invention of the Diving-bell is founded.

Invert a clean dry glass tumbler over a large bason nearly full of water, and when the whole rim is brought exactly parallel with the surface, plunge it perpendicularly downwards. It may now be observed, that the water has risen considerably in the bason; this rising is owing to the displacement by the glass of a volume of water equal to its own bulk; consequently, no water can be in the tumbler: for if the inverted tumbler were filled with water, of course no greater rise could be observed in the bason, than what would be caused by the solid bulk of the sides of the glass which were immersed in it. The reason, then, that no water ascends in the glass, is, that previous to its immersion, it was filled with air, which, pressing upon the water below, prevents its ascent. Another proof that no water has entered the glass, is, that the inside will be found quite dry.

Phosphoric Fire-bottle.

The fire-bottle is founded on the known property of phosphorus to inflame more or less rapidly, according to the state of the substances upon which it is rubbed.

The preparation of these fire-bottles is extremely simple. *About eighteen* or twenty grains of phos-

phorus are to be put into a phial or glass tube, of any length, so that it can be easily held in the hand. The lower part of this tube may be filled with any substance whatever, which is to be pressed down with a cork. A space being reserved for the phosphorus, it is cut into small pieces, and put into the bottle, which is immediately stopped with a good stopper. By heating with precaution, at a lamp, the part which contains the phosphorus, this substance quickly melts, and falls into the shape of the bottle, as it cools: the fire-bottle is then completed. The manner of using it is equally simple. The little bed of phosphorus is lightly scratched with a common match, a very small portion adheres to the match, and on being lightly rubbed upon a piece of leather glove, woollen cloth, cork, &c. it takes fire, and communicates inflammation to the match. A hundred matches in succession may be lighted, without consuming more than a grain and a quarter of phosphorus.

Experimental Illustration of an Electrical Thunder-cloud at Sea.

With a view of illustrating experimentally the advantages to be derived from fixed conductors on ship-board, the facility and safety with which the above mentioned method of their application admits of conducting a charge, and likewise to exemplify their efficacy under every possible situation of the mast, a series of experiments, in which many well known electrical actions are made to bear on these points, were instituted.

A model of a corvette, about five feet long, and of a proportionate width and depth, was placed to float in a reservoir of water, as represented at *Fig.* 14. The masts of this model were fitted with conductors formed of copper slips, on a somewhat proportionate scale; the connections through the keel were likewise complete. It is evident, that when

ships are struck by lightning, the damage sustained is the effect of the electric fluid passing suddenly and violently through them into the sea: hence, from the known laws of electrical actions, the clouds and sea must be considered in opposite electrical states. In order to imitate this by artificial means, it is necessary, first, to place our substitute for the sea in one state, and our representation of a cloud in another. This was done by means of an electrical jar or battery at E, charged either positively or negatively; when charged positively, the water in the outer coating was placed under the influence of the negative side, by means of the metallic wire E A B; a boat A D, having a small wire through the keel, was now connected with this metallic line, and the cloud at C being in connection with the inner coating by means of the flexible silver line M N C, formed of a silver thread, produced a discharge through the ship into the water. In order to approximate as nearly as possible to the manner in which a thunder cloud approaches the point through which it strikes, the cloud C was attached to a silk line, balanced over two wheels set on fine pivots by equal weights W W; this cloud was formed of a light hollow ball of wood, gilded and covered with a mass of cotton wool; its first situation was at the point O, where the conducting metallic thread was shortened through the ring at M, and coiled away inside the jar; by increasing the weight of W it descends, and conveys the charged cloud forward with any required degree of velocity; this velocity can be measured by means of a pendulum at P, which beats seconds, and by the scale *x y* divided into inches: as the ball moves forward, the conducting thread elongates through the ring at M, and preserves the connexion with the inner coating of the jar. The charge was accumulated to a given height, observable by an electrometer, and the conductor on the lower mast surrounded with a detonating powder (*formed of chlo*rate of potash two parts, sul-

phuret of antimony one part,) mixed with a little common gunpowder; a similar quantity was placed in the boat at D. The artificial cloud was now caused to move forward: at the instant of its approaching the main-top-gallant-mast-head, a dense spark passed through the vessel without igniting the powder placed around the conductor, but inflamed that in the boat, in consequence of a spark being produced at the instant of its passing out of the water, by means of the wire through the keel of the boat; the top-gallant-mast-head was surmounted by a brass ball. On repeating the experiments without the ball, the discharge always became dissipated by the action of the pointed mast-head, and presented in the dark a luminous appearance, so that, with some velocities, it was completely drawn off, and in all cases the dense shock was invariably avoided. About eighty square feet of coated surface was used in these experiments. The same effects constantly took place in every possible situation of the masts, and with every species of velocity, whether uniform, accelerated, or retarded, with which the charge approached the mast-head. The constant agreement in the results of these experiments proves the efficiency of a pointed continuous conductor on ship-board, and that its application is calculated to answer the end in view; for if it had not transmitted the charge in the most perfect manner, the detonating powder in contact with the conductor on the mast must have been exploded.

Shadows.

Behind a transparent screen of white cloth, place a *very powerful* light, from which, as the performer, whose image is formed on the screen, recedes, his figure will attain to gigantic proportions; again, when he approaches, and is between the light and the screen, his figure will be more accurately de-

ined; by jumping over the light, he will appear to ascend to a great height, and disappear. By nimble and grotesque movements and attitudes,—by the judicious introduction of any animal, &c.,—the effect may be considerably heightened, and much laughter be excited.

This amusing optical exhibition was successfully employed at the Royal Gardens, Vauxhall, where it excited great applause.

French Method of painting on Silk or Cotton Velvet.

Extend come tracing paper upon the object to be copied, and trace the design upon it with a pencil. Rub the contrary side of this paper all over with lake lac in powder, and apply this reddened surface upon a smooth piece of parchment. With a pencil go over every object separately, using as many pieces of parchment as there are different objects and different colours in the design, so as to transfer every object on a different piece. Afterwards cut out all the pieces of parchment by the transferred lines, and, this done, extend the piece of velvet intended to be painted upon a table covered with a green cloth; place every piece of parchment, one after another, on that part of the velvet where the portion of the drawing ought to be which has been cut in the piece of parchment; and with a pencil charged with a colour suited to that part of the drawing, go over the velvet where it is not covered by the parchment. The same is done for each piece of parchment separately, till the whole drawing is completed. The execution of this process requires a great deal of care and attention, in order to avoid obliterating the design, for the whole part is performed continuedly, without waiting for the part which has just been painted to dry, before commencing another. At last, the parts which may not have taken well, are corrected and finished with a pencil, or by *means of new* pieces of parchment.

Preparation of the Oil used in this kind of Painting.

Grind into very fine powder twenty grains of sal-ammoniac, and twenty grains of sal-prunella. Throw this powder into one pound of the clearest linseed oil that can be obtained, and boil it for three hours. One hour before taking it off the fire, put into it a piece of soft bread, which has been carefully soaked in oil of vitriol, and three large onions cut in pieces. When this bread is almost calcined, and the onions are dissolved, take off the oil, and strain it through a new piece of coarse cloth. Put it afterwards into bottles, and use it for grinding the colours as may be required for painting, observing to employ it with management, that the ground colours shall not run on the glass, but have the consistence of butter. This oil does not spread on the velvet beyond the outlines of the drawing.

To restore decayed Writings.

Cover the letters with phlogisticated or prussic alkali, with the addition of a diluted mineral acid; upon the application of which the letters change very speedily to a deep blue colour, of great beauty and intensity. To prevent the spreading of the colour, which, by blotting the parchment, detracts greatly from the legibility, the alkali should be put on first, and the diluted acid added upon it. The method found to answer best has been, to spread the alkali thin with a feather, or a bit of stick cut to a blunt point. If then the corner of a bit of blotting paper be carefully applied near the letters, so as to imbibe the superfluous liquor, the staining of the parchment may be in a great degree avoided. Care must be taken not to bring the blotting-paper in contact with the letters, because the colouring matter is soft whilst wet, and may be easily rubbed *off.* The acid chiefly employed is the marine; but

both the vitriolic and nitrous succeed very well: they should be so diluted as not to be in danger of corroding the parchment.

Shells.

The matter of the shell is secreted by the covium or skin of the insect, and the form it assumes is regulated by the body of the animal. It is coeval with its existence, and appears pervious to the exclusion of the egg. The solid matter of the shell consists of common lime, united with a small portion of animal matter, resembling coagulated albumen. The mouth of the shell is extended by the application of fresh layers of the shelly matter to the margin, and its thickness is increased by a coating on the inner surface.

Shell is hardened by carbonate of lime; bone by phosphate of lime.

To Stain Wood Black.

Boil some chips of log-wood in water for about a quarter of an hour, then wash the piece of wood with it three or four times, allowing it to dry after each washing. Lastly, wash the wood by means of a common painting brush with vinegar, prepared as follows:—put one ounce of steel, or iron filings, into two ounces of vinegar, keep the phial near the fire, so as to be gently heated for about two hours, then decant the vinegar and keep it for use.

Composition of an Ink similar to China Ink.

Take six parts of isinglass, which are to be dissolved in double their weight of boiling water; in like manner dissolve in two parts of water one part *of Spanish liquorice;* mix the two liquors warm,

and gradually incorporate with them, by means of a wooden spatula, one part of the best ivory black. When this mixture is properly made, it is heated in a water-bath, that the whole of the water may be evaporated. The requisite form is then given to the paste which remains. The colour and goodness of this ink are equal to those of the true China ink.

Vegetable Chimney Ornaments.

In winter an elegant chimney ornament may be formed by cutting the head or thick end of a carrot, containing the bulb, and placing it in a shallow vessel with water. Young and delicate leaves unfold themselves, forming a radiated tuft of a very handsome appearance, and heightened by contrast with the season of the year.

Grand Conjunction.

In 1748, the attention of astronomers was attracted to the conjunction of five planets in one sign of the zodiac,—a phenomenon that had not before occurred since the creation of the universe.

Camera Lucida.

That very compact and elegant instrument, for drawing objects in perspective, called the *Camera lucida*, was the invention of the late Dr. W. H. Wollaston.

In this instrument two plane reflectors are fixed at such angles with regard to each other, that the objects intended to be delineated are seen after reflection from the second mirror, as though they were on the same plane as that whereon the paper is placed which is to contain the drawing. These

plane reflectors may be either common mirrors with a silver coating at the back of each, or two contiguous faces of a glass prism, in which latter case the image will be produced by what is called prismatic reflection. In either case the most convenient position, in which the reflecting surfaces can be arranged, will be such as will cause the rays proceeding directly from the object, and falling as incident rays upon the first surface, after reflection from thence to the second, to emerge from that second reflecting surface in angles of 90 degrees with the direction of the original incident rays: for in these circumstances vertical objects may be projected upon a horizontal plane, and the instrument will be adapted to drawing upon a horizontal surface. Now, if two plane mirrors are used, the incident rays upon the first will make right angles with the emergent rays from the second, when those mirrors are fixed so as to make angles of either 45 or 135 degrees from each other. In this case the mirror which first receives the rays from the object may be entirely silvered at its back, but the second mirror is only to have a sufficient portion silvered to reflect the image of the proposed object to the eye, and thus to allow the paper, on which the drawing is to be made, to be seen, either through an opening of the silvering, or past the edges of the same, by one portion of the eye, while the double reflected object is seen in the silvering by the other portion of the same eye. When prismatic reflection is employed, the prism must not be triangular, as usually constructed, but quadrangular, and the two reflecting surfaces (to produce an angle of 90 degrees between the first incident and the second emergent rays) must make an angle of 135 degrees, while the opposite angle must be one of 90 degrees, and the other two angles may be either respectively equal or unequal at pleasure; then one of the faces which made right angles with each other is to be turned towards the objects to be delineated, and the rays, after passing through that surface and reflection from the

two next faces, will emerge from the fourth under the proposed angle.

The mirrors, or other reflecting surfaces, are mounted in a proper frame, and supported at a suitable distance from the paper intended to receive the drawing: and, when necessary, either a double concave or a double convex glass may be fixed in the frame and properly adjusted, to produce distinct vision when the apparatus is used by short-sighted or long-sighted persons respectively. These concave and convex glasses may conveniently be made of twelve inches focal length; the instrument must then be supported at the distance of twelve inches from the paper, a distance which is convenient enough in other respects.

Dr. Wollaston instituted a comparison between the camera obscura and the camera lucida.

The objections to the camera obscura are—

1st. That it is too large to be carried about with convenience.

The camera lucida is as small and portable as can be wished.

2dly. In the former, all objects that are not situated near the centre of view, are more or less distorted.

In this, there is no distortion, so that every line, even the most remote from the centre of view, is as straight as those through the centre.

3dly. In that, the field of view does not extend beyond 30°, or at most 35°, with distinctness.

But in the camera lucida, as much as 70° or 80° might be included in one view.

Dr. Wollaston remarks further, that by a proper use of the same instrument, every purpose of the pentograph may also be answered, as a painting may be reduced in any proportion required, by placing it at a distance in due proportion greater than that of the paper from the instrument. In this case a lens becomes requisite for enabling the eye to see at two unequal distances with equal distinctness; and in order that one lens may suit for all these purposes,

there is an advantage in varying the height of the stand according to the proportion in which the reduction is to be effected.

Beautiful Appearance in Vacuo.

Take a glass barometer tube, having on the end a steel cap, fastened to the glass with cement. From it must proceed a wire and ball. Fill the tube with quicksilver, and then, by sending up a large bubble of air, and repeatedly inverting the tube, free the quicksilver and iron ball from air: then put a small drop of ether on the quicksilver, and put the finger on the end of the glass tube, and then invert the end in a bason of quicksilver, taking care not to remove the finger from the end of the tube till the latter be immersed under the surface of the quicksilver. When the finger is removed, the mercury will descend, and the ether expand itself: present the metallic top of the tube to a large charged conductor, and a beautiful green spark will pass through the vapour of the ether from the ball to the quicksilver. By admitting a small quantity of air into the tube, an appearance something like a falling star is produced.

Improved Phantasmagoria.

The light of the lamp A, see *Fig.* 15, is thrown by the mirror B and the lenses C and D on the painted slider at E, and the magnifyer F forms the image on the screen at G. This lens is fixed to a slider, which may be drawn out of the general support or box H: and when the box is drawn back on its wheels, the rod I K lowers the point K, and by means of the rod K L adjusts the slider in such a manner, that the image is always distinctly painted on the screen G. When the box advances towards the screen, in order that the image may be dimi-

nished and appear to vanish, the support of the lens F suffers the screen M to fall and intercept part of the light. The rod K N must be equal to I K, and the point I must be twice the focal length of the lens F, before the object L being immediately under the focus of the lens. The screen M may have a triangular opening, so as to uncover the middle of the lens only, or the light may be intercepted in any other way.

The apartment must be deprived of all light, except that which proceeds from the apparatus hid behind the screen, which is of gauze or gummed muslin, posited vertically, which serves as the ground of a picture where the images are depicted by reason of the transparency. At the moment when the operation commences, a spectre appears (as of a skeleton, the head of a celebrated person, &c.) at first extremely small, but which afterwards increases rapidly, and thus seems to advance at a great rate towards the spectators: and when the scene passes before them in a room representing a cave hung with black, a solemn silence being occasionally interrupted by mournful sounds from an appropriate musical instrument, it is not easy for an observer to defend himself from the impression of terror, at the sight of an object in itself formed to produce the illusion, and which finds in the imagination a place already prepared for the reception of phantoms.

Optical Magic.

To make an anamorphosis, or monstrous projection on a plane, draw the square A B C D, *Fig.* 16, of any size at pleasure, and subdivide it into a number of lesser squares. In this square, let the image to be distorted be drawn. Then draw the line *a b*, *Fig.* 17, equal to A B, *Fig.* 16, and divide it into the same number of equal parts as the side of the prototype A B; and in E, the middle of it,

the perpendicular E V, so much the longer,
aw V S perpendicular to E V, so much the
r, as the image is designed to be more dis-
. From each point of division draw right
o V, and join the points *a* and S by the right
S. Through the points *d*, *e*, *f*, *g*, draw lines
el to *a*, *b*; then will *a*, *b*, *c*, *d*, be the space in
the monstrous projection is to be delineated.
tly, in every small square of the space *a*, *b*, *c*,
w what appears delineated in the correspond-
uare A B C D; by this means you will obtain
rmed image, which yet will appear in just
tion to an eye distant from it by the length
V, and raised above it by the height V S.
s by these means that the horizontoviums are

.

image may be also distorted mechanically, by
ating it here and there with a needle, and
g it against a candle or lamp; and observing
the rays, which pass through these little holes,
a plane, or curved superficies, for they will
the correspondent points of the image de-
d, by which means the deformation may be
eted.

the image, whatever it be, *e*, *g*, I H S, be
upon a cylinder of pasteboard, A B C D, *Fig.*
id the perforations being made as above de-
d, place a candle G behind the cylinder, and
upon the ground the points corresponding to
erforations of the image, which will be dis-
more or less, according to the position of the
or the plane, &c. Then, let the picture
s formed be an exact copy of this distorted
, and substitute a metallic speculum in the
of the cylinder, and let the eye of the specta-
ve the same position before the cylinder that
ndle had behind it, the distorted image will,
lection from the speculum, be restored to its
r shape.

To draw the Deformation of an Image upon the convex surface of a Cone.

Let the base, A B C D, of the cone, *Fig.* 19, be divided by radii into any number of equal parts, and let some one radius be likewise divided into equal parts, and through each point of division draw concentric circles: thus will the concentrical prototype be formed. With double the diameter A B, as a radius, describe the quadrant E F G, *Fig.* 20, so that the arch E G may be equal to the whole periphery: then this quadrant, duly folded, will form the superficies of a cone, whose base is the circle A B C D. Divide the arch E G into the same number of equal parts as the craticular prototype is divided into, and draw radii from all the points of division. Produce G F to I, and F I to F G: and from the centre I, with the radius I F, draw the quadrant F K H, and from I to E draw the right line I E. Divide the arch K F into the same number of equal parts as the radius of the craticular prototype is divided into, and draw radii through each of the points of division, from the centre I, meeting E F in 1, 2, 3, &c. Lastly, from the centre F, with the radii, F 1, F 2, F 3, &c. describe the concentric arches. Thus will the craticularectype be formed, the areola of which will appear equal to each other.

Hence what is delineated in every areola of the craticular prototype, being transferred into the areolæ of the craticular ectype, the images will be distorted; yet an eye raised above the vertex of the cone, at a height equal to that of the cone itself, will perceive them in just proportion.

" *filling up Engraving on Silver with a dura-* *Enamel, as practised in Russia, Persia,*

ice of silver, 2½ ounces of copper,

3½ ounces of lead, and 2½ ounces of nitrate of ammonia, melt the metals together, and pour the compound into a crucible, which has been before filled with pulverized sulphur, made into a paste by means of water: the crucible is then immediately covered, that the sulphur may not take fire, and the mixture is calcined over a smelting fire, until the superfluous sulphur is burnt away. The compound is then coarsely pounded, and, with a solution of muriate of ammonia, formed into a paste, which is rubbed into the engraving on silver plate. The silver is then wiped clean, and suffered to become so hot under the muffle, that the substance rubbed into the strokes of the engraving melts, and adheres to the metal. The silver is afterwards wetted with the solution of muriate of ammonia, and again placed under the muffle till it becomes red hot. After this, the engraved surface may be smoothed and polished, without any danger of the black substance, which is an artificial kind of silver ore, either dropping out or decaying.

Beautiful Appearance from the sudden Combustion of Oil.

Pour half a spoonful of olive oil into a small crucible, obscurely red, or at that degree of heat which shall have been discovered by previous experiments. A thick cloud of white smoke will immediately rise, which takes fire at its summit, that is to say, four or five feet distant from the crucible. If, on the contrary, the combustion of the cloud arises from the crucible, it is occasioned by the heat being too great. In that case it will be proper to wait a few minutes, when the phenomenon will appear in all its magnificence.

Method of cutting Glass by Heat.

Take a piece of dense charcoal, made from box, or

some other hard wood, and point it like a pencil. Scratch the glass at the place where the fracture is to begin with any instrument of hard steel, such as the corner of a file. Light the point of the charcoal, and, applying it to the scratch, proceed with pressing it upon the glass in the direction of the intended fracture. The glass will crack in the path of the burning point, and the crack may be either in a right line, or zigzag, or curved, at pleasure. As fast as the point of the charcoal becomes covered with ashes, it should be blown upon with the breath to keep it red hot, or it will not heat the glass sufficiently to produce the desired effect. The scratch made on the glass at the commencement, need scarcely be more than a point.

Very beautiful Artificial Petrifactions.

Put into a retort a quantity of pounded fluor spar, with a few bits of broken glass, and pour upon them some sulphuric acid; fluoric acid gas will be disengaged, holding silex in solution. The subjects that you wish to resemble petrifications must now be moistened with water, and placed in a vessel connected with the neck of the retort. The fluoric acid gas will be absolved by the moisture adhering to the substances, and the silex will be precipitated upon them like a sort of hoar frost, which will have a very beautiful appearance, and is very durable.

To facilitate the Painting on Glass by laying on Mezzotinto Prints, for Magic Lanthorn, &c.

Cut off the margin of the print you intend to use, and lay it in a flat vessel of hot water; let it remain on the surface till it sinks. Take it out and press it between cloths or papers, so that no water may appear on the surface, but the print be quite damp: then lay it, face uppermost, on a flat table, and have

ready a piece of crown glass free from blemishes; lay some Venice turpentine all over one side of it with a soft brush, hold it to the fire that it may be quite equal and thin; then let it fall gently on the print. Press it down, that the turpentine may adhere to the print; also press the print with your fingers, from the middle to the edges of the glass, that no blisters may remain. Wet the print now with a soft cloth, and rub it gently with your finger, and the paper will peel off, leaving the impression on the glass. When it is dry, wet it over with oil of turpentine till it is transparent, and set it by to dry, when it will be fit for painting.

The colours used for the painting, are the usual transparent oil colours.

Subjects for magic lanthorns may be painted by those who cannot paint in oil, on thin paper in water colours, and afterwards varnished to make them transparent.

Powerful Musical Instrument.

Take a common poker, and tying a tape on it at top, so as that both ends of the tape are left at liberty; these ends must be rolled round the first finger of each hand, and then with these fingers stopping the ears close, strike the poker thus suspended against any body. The depth of the tone which this odd musical instrument returns will be amazing. The deepest and largest bell will not equal it.

Imitative Water Spout.

The phenomenon of the water spout may be illustrated by a very easy experiment.

In a stiff paper card make a hole just large enough to insert a goose quill; after cutting the quill off square at both ends, lay the card upon the mouth of a wine-glass filled with water to within the

fifth or sixth part of an inch from the lower orifice of the quill; then applying the mouth to the upper part, draw the air out of the quill, and in one draught of the breath draw in about a spoonful of water; and this you may repeat, the water remaining as before. The water will not ascend to the mouth in a stream, which it would do if the quill reached to it, but broken, and confusedly mixed with the air which ascends with it. The usual phenomena of water-spouts are exactly agreeable to this theory.

The Ocular Harpsichord.

The first person who attempted to supply the organ of vision with the luxuries of light and colour, was Father CASTEL, a learned Jesuit. The account of this instrument was printed at the end of CASTEL'S *L'Optique des Couleurs*, which appeared at Paris in 1740. The ocular harpsichord is a common harpsichord, fitted up in such a manner, that when a certain sound is produced by striking the keys, a colour related to that sound is at the same instant exhibited to the eye in a box or frame connected with the harpsichord; so that, when a piece of music is played for the gratification of the ear, the eye is simultaneously delighted by the display of corresponding colours.

In adjusting the colours and the sounds, Castel lays down the following six propositions.

1st. There is a fundamental and primitive sound in nature, which may be called *ut*, and there is also an orginal and primitive colour, which is the foundation of all other colours namely, *blue*.

2nd. There are three chords, or essential sounds, which depend upon the primitive sound *ut*, and which compose with it a primitive and original accord, and these are *ut*, *mi*, *sol*. There are also three original colours depending on the *blue*, which, while they are not composed of any other colours, *produce* them all, namely, blue, yellow, and red. The

blue is here the note of the tone, the red is the fifth, and the yellow is the third.

3rd. There are five tonic chords, *ut*, *re*, *mi*, *sol*, *la*, and two semitomic chords, *fa* and *si*. There are also five tonic colours, to which all the rest are ordinarily related, namely, *blue*, *green*, *yellow*, *red*, and *violet*, and two semitonic or equivocal colours, namely, *aurora* and *violant*, (related to the *orange* and *indigo* of NEWTON.)

4th. Out of these five entire tones, and two semitones, is formed the diatonic scale, *ut*, *re*, *mi*, *fa*, *sol*, *la*, and *si*; and, in like manner, out of the five entire or tonic colours, and the two demi-colours, are formed the gradation of colours, *blue*, *green*, *yellow*, *aurora*, *red*, *violet*, and *violant*; for the *blue* leads to *green*, which is *demi-blue*; the *yellow* to *aurora*, which is gilded-yellow. The *aurora* leads to *red*, the *red* to *violet*, which is two-thirds of *red*, and one-third of *blue*; and the *violet* leads to *violant*, which has more *blue* than *red*.

5th. The entire tones divide themselves into semitones; and the five entire tones of the scale, a gamut, comprehending in this the two natural semitones, make twelve semitones viz. *ut* natural *ut* dieuze, *re*, *re* dieze, *mi*, *fa*, *fa* dieuze, *sol*, *sol* dieuze *la*, *la* dieuze, and *si*. In like manner there are twelve demi-colours, or demi-tints, and there can be neither more nor less, according to the opinion of painters themselves, and as may be demonstrated by other means. These colours are *blue*, *sea-green*, *green*, *olive*, *yellow*, *aurora*, *orange*, *red*, *crimson*, *violet*, *agathe*, and *violant*. *Blue* leads to sea-green, which is a *greenish blue*; *sea-green* leads to *green*; *green* to *olive*, which is a *yellowish-green*; *olive* to *yellow*; *yellow* to *aurora*; *aurora* to *orange*; *orange* to *red*, the colour of fire; *red* to *crimson*, which is red mixed with a little *blue*; *crimson* to *violet*, which is still more *blue*; *violet* to *agathe*, or *bluish violet*; and *agathe* to *violant*.

6th. The progression of sounds is in a circle, setting out from *ut*, and returning back: thus, *ut*, *mi*, *sol*, *ut*, or *ut*, *re*, *mi*, *fa*, *sol*, *la*, *si*, *ut*. This is called

an octave, when the last *ut* is one-half more acute than the first. The colours also have their progression in a circle.

7th. After an octave, *ut*, *re*, *mi*, *fa*, *sol*, *la*, *si*, there recommences a new one, which is one-half more acute, and the whole circle of music produces several octaves.

Such are the principles upon which the ocular harpsichord was founded.

To shew the Combustion of Zinc in Oxygen Gas.

Take some turnings of zinc, form a ball of it, and affix it to a wire; insert a small bit of phosphorus into the ball, set fire to it, and introduce it quickly into a bottle filled with oxygen gas. The zinc will take fire, and burn with a beautiful green flame surrounded by a white one.

Or,

If a current of oxygen gas be conveyed to filings of the metals, they will burn with great rapidity. For this purpose, fill a large bladder with oxygen gas, and adapt it to a tube; by pressing the bladder and throwing the gas on a piece of ignited charcoal, on which filings of metal have been put, they will burn rapidly. The filings of metal which exhibit the most brilliant appearances, are those of zinc, copper, antimony, iron, and steel.

Sonorous properties of different Gases.

By causing a small tin pipe, brought into contact with a cock in the neck of a bell glass, to be blown by gas contained in a bladder applied to the external aperture of the cock, it will be observed, that the sound is a semitone lower with azotic and oxygen gas than with atmospheric air, a third lower with carbonic acid gas, and nearly the same with nitrous

gas; but, with oxygen gas, from nine to eleven tones higher than the air that surrounds us. A mixture of azote and oxygen, in the same proportions as in the atmospheric air, will give the same tone as the latter; but when the mixture of these gases is not uniform, the sounds are totally discordant.

When a plate of glass is agitated by means of a bow, if some dust is strewed over the glass, the former will appear to have arranged itself symmetrically, after the plate ceases to emit sound. Under the like circumstances, the figures are always the same, their changes depending only upon the gravity or acuteness of the tone.

Artificial Corona.

Artificial coronas may be made in cold weather, by placing a lighted candle in the midst of a cloud of steam; or if a glass window is breathed upon, and the flame of a candle placed at some distance from the window, while the operator is also at the distance of some feet from another part of the window, the flame will be surrounded by a coloured halo.

Changes of the Kaleidoscope.

The following curious calculation has been made of the number of changes this instrument will admit.

Supposing the instrument to contain twenty small pieces of glass, &c. and that you make ten changes in each minute, it will take the inconceivable space of 462,880,899,576 years, and 360 days to go through the immense variety of changes it is capable of producing. Or, if you take only twelve small pieces, and make ten changes in each minute, it will then require 33,264 days, or 91 years and 49 days, to exhaust its variations.

A Multiplying Glass.

Into a rim of brass, about the size of a half-crown piece, and a quarter of an inch thick, fix a plate of the same metal, perforated with holes about the size of a small pea. Between two slightly convex glasses, put sufficient quicksilver (well purified) to cover the surfaces, and carefully cement the edges of the glass to prevent it from escaping; then fix it into the rim of brass over the perforated plate. By this means a fair lady may see her sweet face multiplied to the number of perforations in the brass plate.

Electrical Orrery.

Fig. 21 is a kind of orrery, for showing the earth's motion round its axis in twenty-four hours, the age of the moon from change to change, and all her various phases during that time. *a* is the horizontal board or stand of this machine, and *b* is the great wheel, with 18 floats, or wings, for the electric stream to act upon, and turn the wheel. On the axis of this wheel is a trundle *c*, of eight staves, for turning the wheel *f* of 32 teeth, on whose axis is a trundle *g* of 8 staves, for turning the wheel *h* of 59 teeth, which will go once round in the time the great wheel *a* goes round 29½ times.

A light hollow globe *d*, representing the earth, with its meridians, equator, tropics, polar circles, and poles, is put upon the top of the axis of the great wheel *a*, and on the same axis is an index *e*, which goes round a small dial-plate of twenty-hours, in the time that the earth *d* turns round. An ivory ball *i* is placed on the top of the axis of the wheel *h*, half black and half white, to represent the moon; below which, on the same axis, is an index *k*, which goes round a small plate divided into 29½ equal parts, for the days of the moon's age from change to change. So that, in the time the great wheel *a*, the earth *d*,

nd the hour index *e* make 29½ revolutions, the noon *i* and the index *k* make only one; and in that ime, by shewing herself all round to the observers, hey see all her different phases or appearances, like hose of a real moon in the heavens.

The above may be very readily constructed of tout card paper.

The Diadem of Beatification.

Put a hoop of leather that is silvered and lackered ound a person's head, and let him be electrified on ie glass footed stool; then let a person standing a the floor hold the tips of his fingers near the oop, moving them round and round it, and brisk ashes of electric lightning will come from the hoop) the fingers, and feel like a gentle cool breeze of ind.

Beautiful Pictures produced by the Polyangular Kaleidoscope.

In order to convey some idea of the effect pro-ıced by the kaleidoscope in grouping figures, we ıfer to the plate for *Fig.* 22, which is a design cre-ed by the instrument, from a single figure. The ıclination of the mirrors by which the figures are ranged is 60°, or one-tenth of a circle; and there-re the object is multiplied *ten* times, so as to give e pair of direct and inverted images.

The effect which is produced by a simple outline ill convey some idea of the beauty which must ıaracterise the designs when the figures are finely ıaded, or chastely coloured.

When the figures which are wished to be intro-ıced are larger than the aperture of the kaleidos-pe, the lens must be used, and the figures placed such a distance as to reduce them to the proper agnitude.

By the application of the lens, paintings or sta-

tues of any size may be reduced and admitt
the figure.

To measure the Height of a Tower, &c.

By means of the shadow projected on a
zontal ground, we may measure with tolera
curacy the height of a tower, or any other
object. The method is this:—Fix a stick ve
in the ground; measure the part of it that is
the ground; measure also its shadow and th
dow of the tower. The length of the shad
ing proportional to the respective height of t
objects producing them, we shall have the he
the tower by multiplying the length of its s
by the height of the stick, and dividing the p
by the length of the shadow of the stick.

To estimate the Depth of a River.

The bottom of a river always appears ne
us than it really is; but, if the spectator sta
a bank, just about the level of the water, it is
one-third deeper than it appears.

Composition for injecting various Anatomical
rations.

Melt together an ounce of zinc, an ounce
muth, and an ounce of lead, to which add
proportion of mercury; melt them, and inje
vessels of any anatomical preparation, or corre
of various cavities of the human body, as th
the ear, may be obtained with it. The
structure may be corroded and separated by
of a solution of potass in water; and the m
cast will be preserved in an insolated state.

Metallic Crystals.

Dissolve ten grains of the crystallized nitrate of silver in a wine glass full of water; and immerse a clean slip or rod of copper, a beautiful metallic precipitate will immediately begin to take place upon it. The silver will be seen, as it were, to dart into existence in the crystalline form.

Curious Experiment in Music.

A very curious experiment was first pointed out by Wallis, but which was neglected till it occurred in the observations of Sauveur, who has since passed for the inventor. The experiment is this.

If we stretch a musical cord above a board, and divide it into two unequal portions, yet respectively commensurable by means of a slight obstacle which only presses moderately, these two parts being struck successively will yield the same sound, which will be different from that of the whole cord: and such indeed will that sound be, that if we represent by the most simple numbers the ratio between the lengths of the two parts of the cord, the sound which is heard, the slight obstacle being interposed, will be that of a cord which is represented by unity. Thus, if a cord were divided into two parts, which are respectively as the numbers 3 and 2, in which case the corresponding sounds would be in the relation of *ut* and *sol* rising, if the lengths of the two determined their resonance, then the sound will be that of the cord 1, that is to say, the *sol*, which is the acute octave to the sound given out by the smaller portion in the ordinary case.

It would seem, then, that each part subdivides itself into as many equal portions, as the number that measures it contains units. Hence, between two neighbouring subdivisions there is a point of rest, or a node, and at the middle of each subdivision

the undulation forms a bellied part, as in a cord which vibrates from end to end. In the preceding example, the larger part subdivides itself into three, and the smaller into two; so that the sound *ut* is rendered at once by all the subdivisions, which are thus found in unison one with another. It is obvious that the smaller part ought not to subdivide itself when the sound to which it is analogous has the unit for its impression; for then the same sound is yielded by the smaller part, as by each of the subdivisions of the greater.

Such, therefore, is the mechanism on which the series of unisons given by this experiment depends, that the slight obstacle which divides the cord merely prevents the total vibrations, but permits a communication to subsist, or a mutual dependence between the two parts, whence their vibrations tend to accord perfectly, or, in other words, to become isochronous. Of consequence, they are forced to subdivide themselves, but they do this as little as possible: so that the number of subdivisions is always the smallest among all those which would furnish isochronism.

Thus, in the preceding example, if the cord 2 made total vibrations, the two thirds of the cord 3 might be able to put itself in union with it; but there would remain one-third which would perform its vibrations separately: now it is this third which, being alone proper to determine the isochronism, gives law to all the rest.

Sauveur rendered sensible to the eye the distinction between the nodes and the moveable parts, by placing at the point of each node a chevron of white paper, and another of coloured paper, about the middle of each vibrating part. At the moment when the cord commenced vibration, all the coloured pieces were seen to fall off, while all the white ones remained in their places. This experiment will succeed very well, if we use a violin string, by dividing it with a bridge of pasteboard, after having stretched it upon a board; and making it vibrate by lightly

drawing the bow across near to the wooden bridge, on which either extremity of the string rests.

To Bronze Plaster Figures.

Bronzing is colouring plaster, or other busts and figures, with metallic powders, to give them the appearance of metal. The powders used for this purpose are either copper filings, anvum musivum, or copper precipitated from its solution in aqua fortis by iron. Having done over the substance to be bronzed with either isinglass size, japanners' gold size, or, in some cases, with drying oil or oil paint, the powders are rubbed on, taking care that the projecting parts receive more of the powder than the cavities, to imitate the brightness on those parts of bronze which are liable to be rubbed.

To take Casts from Medals.

To take copies of medals, a mould must first be made; this is generally either of plaster of Paris, or of melted sulphur.

Having oiled the surface of the medal with a bit of cotton wool dipped in oil of olives, put a hoop of paper round it, standing above the surface of the thickness you wish the mould to be. Then take some plaster of Paris, mixed with water to the consistence of cream, and with a brush rub it over the surface of the medal, to prevent air holes appearing; add more plaster immediately to make it sufficiently thick. In about half an hour it will be so hard you may take it off; then pare it smooth on the back and round the edges neatly. Dry it before a brisk fire, if the weather be cold or damp.

To prepare this mould for casting sulphur or plaster of Paris in, take half-a-pint of boiled linseed oil, and *one ounce* of oil of turpentine, mix them

[illegible] bottle, when warm, pour some of it into a tea-cup, rub on the surface of the mould a little of the oil, and when it has sucked it in, do it again. Repeat this till the oil seems to saturate the mould, then with a little cotton wool rub it well, wipe it carefully off. Lay it in a dry place for a few days, and it will acquire a very fine surface.

The last plaster of Paris in this mould, proceed as above directed for steaming the mould itself, first filling the mould with lime-ash.

If sulphur casts are required, it must be melted in an iron ladle.

Sulphur must not be poured in silver medals, as it will tarnish them.

Another Method with Isinglass.

Dissolve isinglass in water over the fire, with a hair pencil lay it over the medal, and let it dry. When it is hard raise it up with the point of a pen-knife, and you will have a shiny impression of the medal.

Breathe on the concave side of the impression, and lay gold leaf on it which, by shining through, will make it appear like a gold medal, or like a copper one by mixing a little carmine with the isinglass, and laying gold leaf as before; or any colour may be given to the isinglass by mixing the requisite colour with it.

To make Sulphur Red or Green, or to resemble Marble.

Take two ounces of the best stone-brimstone, and melt it slowly over a gentle fire; then add an ounce of vermilion, stir them well together, and pour the composition over the surface of the mould, immediately pour it off again, and fill the mould to a thickness with common brimstone; let it cool, pare it, and rub the surface with clean

otton to give it a polish. To make it green, add ne same quantity of the best smalt, instead of ermilion; but it requires more stirring to mix roperly.

To imitate a beautiful Marble.

Mix with the brimstone any several colours separately, and make them into squares of equal sizes; ispose them according to your fancy, in an iron ame that will open with a joint; then melt them ogether, and the colours will unite in a pleasing anner, and each will appear distinct. When you elt it, be careful not to shake it, and let it cool y degrees.

Sulphur may be made to have a more solid metallic appearance, by rubbing it over with powder f black lead.

The Self-moving Orrery.

The Busby Orrery, unquestionably the most beautiful contrivance of modern times, for the popular exhibition of astronomical phenomena, ranks high, as well for its mechanical merit as its singular beauty of action: it is properly termed a self-acting machine, and, to the eye of taste, is equally charming in its conception, its organization, and its effect; and of which the following is a description:

In the centre of Mr. Busby's exhibition room was placed a circular reservoir, five feet diameter. (See *Fig.* 23.) The Sun, represented by a ball of nine inches diameter, sustained upon a slender shaft, about two feet above the surface of the water, was borne by a small circular floating vessel in the middle of the reservoir; this vessel carried a syphon, which discharged a minute lateral stream into a separate floating rim, or concentric circular vessel which surrounds it. The re-action of this discharge causes the vessel bearing the Sun to revolve upon an

axis erected in the centre of a bar, extended diametrically across the inner circle of the rim, or surrounding vessel. The water thus received into the room flows along a tube beneath the surface of a reservoir, and enters a floating cylindrical chamber at the other extremity. In the centre of this chamber a tube is erected, through which a forked rod passes, and bears the Earth, represented by a ball of three inches diameter, at an approximate elevation, and having its axis duly inclined to the ecliptic. A separate floating rim surrounds the cylindric chamber, bearing the shaft which carries the Moon on one side, and a re-acting syphon on the other, the discharge from which impels it round the shaft which bears the Earth. This floating rim also acts, by contact, upon a small wheel, attached to a slender rod, communicating by an universal joint with the axis of the Earth, and thus causes that body to revolve; while the action of a vertical wheel, with a radiating axis rolling round a horizontal circle fixed to the rod sustaining the Earth, gives motion to a small crank, which imparts an ascending and descending motion to the Moon, and produces the obliquity of its orbit; and a calculated disparity between the diameters of the vertical wheel, and the circle upon which it rolls, causes these ascending and descending motions to take place in a less period than one revolution of the Moon, and thus gives the due changes of the nodes.

The shaft which bears the Earth is continued beneath the surface of the water, and a flat plate, of six inches diameter, is connected with a plate of equal diameter at the circumference, by three parallel and oblique rods extending to it at the bottom of the centre of the reservoir, thus preserving the parallelism of the Earth's axis on a principle analogous to that of a parallel ruler, at the same time the lateral motion of the centre vessel bearing the Sun is prevented by a spur, which embraces the circumference of the plate beneath.

But, as the water which is discharged by the two

syphons already described, would soon fill the receptacles, the operation of a third syphon is introduced, which carries away the superfluous water, and by its lateral discharge on the outside of the general reservoir, gives the annual motion of the Earth and Moon about the sun.

We have thus attempted to describe the construction of this beautiful machine; but description does but imperfectly convey an idea of its novelty and beauty of action.

Another simple Hygrometer.

The following is the most lasting and convenient mode of constructing an instrument of this kind.

Take a very nice balance, and place in it a sponge, or other body, which easily imbibes moisture, and let it be in equilibrio, with a weight hung at the other end of the beam. Now, if the air become moist, the sponge becoming heavier will preponderate; if dry, the sponge will be raised up. The balance may be contrived two ways; by either having the pin in the middle of the beam, with a slender tongue, a foot and a half long, pointing to the divisions on the arched plate fitted to it; or, the other extremity of the beam may be made so long, as to describe a large arch on a board placed for the purpose.

To prepare the sponge, it may be necessary to wash it in water, and when dry, in water or vinegar, in which sal-ammoniac or salt of tartar has been dissolved, and let it dry again: then it is fit to be used.

Chinese Shadows.

This ingenious instrument consists in moving, by pegs fastened to them, small figures cut out of pasteboard, the joints of which are all pliable, behind a piece of fine painted gauze, placed before an

opening in a curtain, in such a manner as to exhibit various scenes, according to pleasure; while the opening covered with gauze is illuminated, towards the apartment where the spectators sit, by means of light reflected back from a mirror, so that the shadows of the pegs are concealed. When it is requisite to cause a figure to perform a variety of movements, it is necessary to have several persons, who must be exceedingly expert. When a snake is to be represented gliding, the figure, which consists of delicate rings, must be directed, at least, by three assistants.

This amusement, which one can hardly see the first time without pleasure, is a Chinese invention. Many years ago, Chinese boxes were seen, on which such moveable figures were apparent only when the box was held against the light. In China, these shadows are used at the well known feast of lanterns.

Gilding.

Fifty thousand pounds worth of gold and silver are said to be annually employed in Birmingham in gilding and plating, and, of course, for ever lost as bullion.

Dry Gilding.

Dry gilding, as it is called by some workmen, is a light method of gilding, by steeping linen rags in a solution of gold, then burning them, and with a piece of cloth dipped in salt water, rubbing the ashes over silver intended to be gilt. This method requires neither much labour, nor much gold, and may be employed with advantage for carved work and ornaments.

Gold Varnish.

Take gum lac, which, having freed from all impurity, put into a small linen bag, and wash it in pure

water, till the water no longer becomes red: then take it from the bag and dry it. When it is perfectly dry, pound it very fine to an impalpable powder. Then take four parts of spirit of wine and one part of the gum, mix these well together, and, having put them into an alembic, graduate the fire so that the gum may dissolve. When dissolved, strain it through a piece of strong linen cloth, and preserve the liquor in a glass bottle closely corked. This is the gold varnish, which may be employed for gilding any kind of wood. It is to be applied as follows: With a very soft brush dipped in the liquor, wash over gently, three times, the wood which has been silvered; letting it dry between the application of each coat of varnish, it will be extremely beautiful, and resemble the finest gold.

Artificial Mahogany.

The following method of giving any species of wood of a close grain the appearance of mahogany in texture, density, and polish, is said to be practised in France with such success, that the best judges are incapable of distinguishing between the imitation and mahogany. The surface is first planed smooth, and the wood is then rubbed with a solution of nitrous acid. One ounce and a half of dragon's blood, dissolved in a pint of spirits of wine, and one-third of an ounce of carbonate of soda, are then to be mixed together and filtered, and the liquid in this thin state is to be laid on with a brush. This process is repeated, and in a short interval afterwards the wood possesses the external appearance we have described. When the polish diminishes in brilliancy, it may be restored by the use of a little cold-drawn linseed oil.

New Stain for Wood.

The new stain proposed by Mr. Hill consists of a decoction of walnut or hickory bark, with a small

quantity of alum dissolved in it, in order to give permanency to the colour. Wood of a white colour receives from the application of this liquor a beautiful yellow tinge, which is not liable to fade. It is particularly adapted for furniture made of maple, particularly that kind of it which is called bird's-eye, and which is commonly prepared by scorching its surface over a quick fire. The application of the walnut dye gives a lustre even to the darkest shades, while to the paler and fainter ones it adds a somewhat greenish hue, and to the whiter parts various tints of yellow. After applying this stain to cherry and apple wood, the wood should be slightly reddened with a tincture of some red dye, whose colour is not liable to fade. A handsome dye is thus given to it, which does not hide the grain, and which becomes still more beautiful as the wood grows darker by age.

Hatching Fish.

The Chinese have a method of hatching the spawn of fish, and thus protecting it from those accidents which ordinarily destroy so large a portion of it. The fishermen collect with care, on the margin and surface of waters, all those gelatinous masses which contain the spawn of fish. After they have found a sufficient quantity, they fill with it the shell of a fresh hen egg, which they have previously emptied, stop up the hole, and put it under a sitting fowl. At the expiration of a certain number of days, they break the shell in water warmed by the sun. The young fry are presently hatched, and are kept in pure fresh water till they are large enough to be thrown into the pond with the old fish. The sale of spawn for this purpose forms an important branch of trade in China.

Simple and excellent Drawing Board.

The best kind of drawing boards are made with a frame and a moveable pannel, upon which the paper is simply put wet, and then forced into the frame, where it is confined by wedges at the back; the paper, which had expanded and blistered up much when wet, will dry quite flat and tight, and will be much better for drawing upon than when loose. It is necessary to mention, that all the angles of drawing boards should be exactly square.

Artificial Diamonds and other Gems.

The base of all artificial stones is a paste composed of silex, potash, borax, oxide of lead, and sometimes arsenic. The best silex is obtained from rock crystal, and the next best from white sand or flint. The following are two receipts for making good paste.

No. 1.

	Grains.
Rock crystal	4056
Minium (red lead)	6300
Pure potash	2154
Borax	276
Arsenic	12

No. 2.

Sand	3603
Ceruse (white lead)	8508
Potash	1260
Borax	360
Arsenic	12

Chrystallization.

Every substance in chrystallizing has a tendency to assume a particular figure. Common salt crys-

tallizes in cubes; Epsom salt in six-sided prisms; alum in octohedrons; sugar-candy in oblique four-sided prisms, with wedge-shaped summits.

Extraordinary Diversity of Colours used in Mosaic Work.

In Mr. Cadel's Travels, an account is given of the manufacture of mosaic, in which it is stated, that 17,000 tints of colour are employed in imitating the finer paintings. In a very amusing work of the celebrated Göethe, entitled "Winkelmann und Seit Jahrhundert," it is stated that about 15,000 varieties of colour are employed by the workers in mosaic at Rome, and that there are 50 shades of each of these varieties, from the deepest to the palest, thus affording 750,000 tints, which the artist can distinguish with the greatest facility. We should imagine, with the command of 750,000 tints of colour, that the most varied and beautiful painting might be perfectly imitated; yet this is not the case, for the mosaic workers find a want of tints, even amidst this astonishing variety.

To shew the Hour of the Day by a Ball of Metal.

A metal ball graduated on the surface, in the same manner as the index stem to an hydrometer, with a balance to preserve its equilibrium, must first be exhausted of air, which being effected, place it in a vessel filled with water, which may be allowed to enter by a small aperture, and it will gradually sink till the ball is filled: this, if the ball is about twelve inches in diameter, and the aperture of a proportionate size, will not take place in less than twelve hours.

Composition of Ancient Statues.

According to Pliny, the metal used by the Romans for their statues, and for the plates on which they engraved inscriptions, was composed in the following manner. They first melted a quantity of copper, into which they put one-third of its weight of old copper, which had been long in use; to every 100 lbs. weight of this mixture they added 12½ lbs. of an alloy composed of equal parts of lead and tin.

New Method of making Single Microscopes of Glass.

Take a piece of platinum leaf, about the thickness of tinfoil, and make two or three circular holes in it, from one-twentieth to one-tenth of an inch in diameter, and at the distance of about half an inch from each other. In the holes put pieces of glass, which will stick in them without falling through, and which are thick enough to fill the apertures. When the glass is melted at the flame of a candle with the blow-pipe, it forms a lens which adheres strongly to the metal, and the lens is therefore formed and set at the same time. The pieces of glass used for this purpose should have no mark of the diamond or file upon them, as the mark always remains, however strongly they are heated by the blow-pipe.

The lenses which are larger than one-tenth of an inch, are not so good as the rest, and the best are even of a smaller size than one-tenth. The reason for using platinum is, that the glass is more easily and more perfectly melted in this than in any other metal, which may arise, perhaps, from its requiring a more intense heat to fuse it, or to impair its brightness.

On the application of the Kaleidoscope to the Magic Lantern, Star Microscope, and Camera Obscura.

The general principle of the apparatus requisite for this purpose, is shewn at *Fig.* 24, where C D G F is the tube containing the reflectors A O E, &c. The objects from which the pictures are to be created are placed in the cell C D, which may be made either to have a rotary movement round the axis of the tube, or to slide through a groove, like the sliders of a magic lantern. These objects are powerfully illuminated by a lens B, which concentrates upon them the direct light of the lamp or candle at H, and also the part of the light which is reflected from the mirror M N. At the eye end E of the kaleidoscope is placed a lens L L, close to the end of the reflectors, and having its centre coincident with the centre of the aperture at E. In order that this lens may form behind it an image P P of the objects placed in the object plate C D, its focal length must be less than the length A E of the plates. If the focal length of L L is so small as one half of A E, then it follows, from the principles of optics, that the distance L P at which the image is formed behind the lens, will be precisely equal to the distance A E of the object; but this is obviously too small a distance, for the diameter of P P would be equal only to the apparent diameter of the circular aperture of the kaleidoscope, or to twice A O. Hence it is necessary, that the focal length of the lens L L be less than A E, and greater than half of A E. Two-thirds, or three-fourths of A E will be found a suitable focal length; for if it is larger than this, the image will be formed upon the wall at two great a distance from the instrument.

When the instrument is thus fitted up, an enlarged image of the pattern will be thrown upon the wall, or screen, or any white ground. By turning the object plate round its centre, or, if it is a rectilinear one, by pushing it through the groove, and

e same time giving it a rotary motion, the
n on the wall will undergo every possible
ormation, and exhibit to the spectators, in a
ified form, all those variations which would
been observed by applying the eye to the ka-
cope.

ien the preceding apparatus is used in day-
so that the objects are illuminated by the
of the sun, the mirror M N is unnecessary.
:aleidoscope, &c. must, however, be attached
e part of the frame of a solar microscope,
goes into the aperture in the window shutter.
the most brilliant light is obtained from the
ng of oxygen, an oxygen lamp is peculiarly
for displaying the pictures of the kaleidoscope
umber of spectators.

e patterns which are created by the compound
loscope from natural objects, or from objects
endent of the instrument, may in like manner
hibited to several spectators at once. If the
ts are in a room, such as bunches of flowers,
es, human figures, or large pictures, they must
aced in one apartment, and strongly illumi-
. The lens must then be placed upon the end
of the kaleidoscope, the object plate C D
g been removed, and must be so adjusted, that
mages may fall exactly upon the end A O of
flectors. The objects may be placed at any
ice from the lens, from six inches to twelve
according to their magnitude, and the pictures
e exhibited with great distinctness and effect
the wall of the other apartment. If a blazing
employed, the most brilliant display of fire-
s may be exhibited. When the objects are out
ors, such as trees, shrubs, &c. the kaleidoscope,
its two lenses, must be fixed on the circular
ng of a window shutter, and the picture re-
d upon a screen, as in the camera obscura.

nilar effects may be produced in a portable ca-
obscura, by placing the apparatus C F L L D G
e *moveable* drawer of that instrument. If the

lens L L is of such a focal length as to
formation of the image within the instru
picture will be finely displayed upon t
glass, and may be copied with great exact

In order to render the effect as brillian
ble, the inclination of the reflectors shou
present case, never exceed 30°, or migh
36° or 45°. The objects should be select
as possible, and none with dark tints ou
admitted into the object plates.

To render Ivory or Boxwood luminou

Place an ivory ball on the prime conduc
machine, and take a strong spark, or send t
of a Leyden bottle through its centre, the
appear perfectly luminous; but if the c
not taken through the centre, it will pass
surface of the ball and corrode it. A sp
through a ball of boxwood not only illumi
whole, but makes it appear of a beautiful
or rather fine scarlet colour.

The Invisible Girl.

This very ingenious apparatus was publi
bited both at Bristol and London for a con
period, during which time no discovery wa
its internal mechanism; and it is probable
construction would have remained a secr
but the exhibitors, but for the ingenuit
(now Professor) Millington, who, in a c
lectures delivered in the winter of 1806, e
the manner in which it was performed.

The *visible* part of the apparatus connec
the *invisible girl* was thus constructed: firs
hogany frame resembling a bedstead, havin
corners four upright posts about five feet h
united by a cross-rail near the top, and two

cross-rails near the bottom to strengthen the frame, which was about four feet square. The frame thus constructed was placed upon the floor, and to the top of each of the four pillars were attached as many strong bent brass wires, converging towards the top, where they were secured by a crown and other ornaments. From these wires a hollow copper ball was suspended by slight ribbons, so as to cut off all possible communication with the frame. The globe thus supported was supposed to contain the invisible being, as the voice apparently proceeded from the interior of it: and, for this purpose, it was equipped with four trumpets, placed round it in a horizontal direction, and at right angles to each other: the trumpet mouths coming to within about half an inch of the respective cross-rails of the frame surrounding them.

When a question was proposed, it was asked from any side of the frame, and spoken into one of the trumpets, and an answer immediately proceeded from the whole of them, so loud as to be distinctly heard by the enquirer, and yet so distant and feeble, that it appeared as if coming from a very diminutive being. In this the whole of the artifice consisted; and the variations were so contrived, that the answer might be returned in several languages; a kiss might be returned, the breath producing the voice was felt, and songs were sung, accompanied by the piano-forte, &c. To produce this allusion, the sound was conveyed by a tube, in a manner similar to the old and well known contrivance of the *speaking bust;* the invisible girl only differing in one circumstance; that an artificial echo was produced by means of the trumpets and hollow globe, in consequence of which the sound was completely reversed.

In the invisible girl, the orifice of the tube was in one of the hand-rails just opposite the mouth of one of the trumpets, the opening being concealed by reeds and other mouldings; the tube itself, which was about half an inch in diameter, ran through half the hand-rail, then down one of the

corner posts, and from thence under the floor till it reached a large deal case, almost similar to an inverted funnel, along the side of which it rose till it came nearly in contact with the ear of the confederate, who, with a piano-forte, &c. was concealed in this case. Any question asked by a voice directed into one of the trumpets, was immediately reflected back from the concave interior surface of the globe to the orifice of the tube, along which it was conveyed, so as to be distinctly heard by the person in the deal case, who returned the requisite answer, which appeared to come precisely from the interior of the globe. A small hole, closed with glass, was likewise left through the deal case, and side wall of the apartment, by means of which the concealed person had an opportunity of observing and commenting upon any circumstance which occurred in the room.

Musical Figures resulting from Sounds.

Cover the mouth of a wide glass, having a footstalk with a thin sheet of membrane, or vegetable paper, over which scatter a layer of fine sand. The vibrations excited in the air by the sound of a musical instrument, held within a few inches of the membrane, will cause the sand on its surface to form regular lines and figures with astonishing celerity, which vary with the sound produced, affecting a particular mode of division, according to the number of vibrations.

Magnifying Power.

The magnifying power of reflecting telescopes may be increased merely by varying the distance between the eye-pieces and the great speculum, and then producing distinct vision by a new adjustment of the small mirror.

Imitation of Gold.

M. Dittmer has published, in the Hanoverian Magazine, the following account of a compound metal, invented by Professor Hermbstadt:

Take of pure platina ..... 16 parts.
pure copper ..... 7 „
pure zinc ..... 1 „

Put them in a crucible, and cover them with powdered charcoal, and keep them over the fire till they are perfectly melted into one mass.

This compound is stated not only to be of the same colour as gold, but to be equal to it in specific gravity, density, and ductility.

Damp Walls.

A hall, of which the walls were constantly damp, though every means were employed to keep them dry, was intended to be pulled down, when M. Schmitthals recommended, as a last resource, that the walls should be washed with sulphuric acid. It was done, and the deliquiescent salts being decomposed by the acid, the walls dried, and the hall was afterwards free from dampness.

Forest Vegetation.

There are some singular facts related relative to the antiquity of trees, in Major Rooke's sketch of the forest of Sherwood. Upon some timber cut down in Berkland and Bilhaugh, letters have been found cut or stamped in the body of the trees, denoting the king's reign in which they were marked. The bark appears to have been cut off, and *then* the letters to have been cut in: after which, the next year's wood grew over it without adhering where the bark had been cut. The cyphers in this case were found to be of James the First, William and

Mary, and (one) of King John. One of the c
of James was about one foot within the tre
one foot from the centre: it was cut down in
The tree must have been two feet in diame
two yards in circumference, when the ma
cut. A tree of this size is generally estima
120 years' growth; which number being subt
from the middle year of James's reign, would
1492, about the date of the planting of th
The tree with the cypher of William and
displayed that mark about nine inches with
tree, and three feet three inches from the c
this tree was also cut down in 1786. The
of John was eighteen inches within the tree
was cut down in 1791), and rather more than
from the centre. The middle of John's reig
1207, from which subtracting 120, the num
years requisite for a tree's growth to arrive
diameter of two feet, the date of its planting
appear to have been 1085, or about twenty
after the Conquest. But, then, this tree, wh
down in 1791, must have been 706 years old,
scarcely credible: for it appears from trees
marks are better authenticated, that those exa
the same size, when marked, had increased t
inches in diameter in 173 years, whilst this tr
encreased no more than eighteen inches i
years. Major Rooke says, that several tree
this mark have been cut down, so that decept
mistake is scarcely possible.

Permanent Expansion of Glass.

It has been ascertained, that after glass has
exposed to a great heat, on cooling, it never re
its original volume.

Artificial Volcano.

Mix 28 pounds of sulphur and 28 pounds of

filings together, and add as much water as will form the whole into a paste: bury the mass about two feet below the surface of the earth, and in twelve or fourteen hours so much heat will be generated, as to swell the earth, and cause an artificial volcano, throwing up whatever impedes its progress, and scattering round ashes of a yellowish and black colour. To succeed in this experiment, advantage should be taken of warm weather, and after the tenth hour of burying the mass, care must be taken not to approach too near its situation.

Very beautiful Effect.

A very beautiful effect will be produced by throwing into a gallipot, containing sulphuric acid, four grains of chlorate of potass, half a grain of phosphorus, half a grain of sulphur, and half a grain of charcoal; the flame will be intense, and the explosion violent.

The combustible materials should be gently mixed with a wooden skewer in a spoon, from which they are to be thrown into the acid.

The numerous Changes which may be rung upon Bells.

It excites our astonishment to know, there can be so many changes made with fourteen bells, that if they were to change ten times every minute, (which would be 140 strokes), yet it would require *sixteen thousand five hundred and seventy-five years to ring them all.*

The probability of Two Heads being thrown with Halfpence.

If, in tossing up two halfpence, the probability was required of their being both heads, it must first

be considered, that the probabilities of thro head with the first halfpenny is ½, as there chance for a head, and two chances in *all*, being both a head and a tail), and with the halfpenny the chances are the same; then multiplied into ½, which is equal to ¼, will the probability required; showing that th four chances in *all*, but only one chance event to happen, being three chances to one it happening: and this will appear true b dering, that with the head of the first hal either the head or tail of the second may b bined; and the same with the tail of the fir penny, making together four combinations head, tail; tail, head; head, head; and ta These are all the ways that two halfpence ca up, and there being only one way out of f them to come up head, head, the chances ar to one against it happening, as above.

The probability of throwing an Ace twice in su with one Die.

If the probability was required of throw ace twice in succession with one die; or, w the same, of throwing aces the first throw w dice, the probability will be ⅙ multiplied t ⅙, being 35 chances to 1 against it: and if t bability was required of throwing some one other five faces each throw, it would be ⅚ being 25 chances in favour of the event, a difference, or 11 chances in 36 for one ace to come up in two throws with one die, or throw with two dice.

The Prickly Pear.

The steel fangs with which this pear sh strument is furnished must, like the bolt a

mon latch, be chamferred from the point, so that, on its being inserted within the teeth, the bolts will instantaneously spring out, and no power short of the key, previously made to fit the wards of the lock, will suffice to free those who are thus ensnared.

How to Write in the Dark.

Two planes of ebony, of equal length and breadth, similar to a parallel ruler, and joined at each end by racks, the side of which being graduated to the width of the line intended, will serve as certain guide, and by use of this instrument, a blind person, or a person in the dark, may write with the greatest accuracy. If ivory tablets or a slate is used, a fine wire drawn with a steel point may be readily felt by the point of the pencil.

Plane Specula may be made to multiply the Images of one Object.

A wonderful property is exhibited by two specula, so constructed that they may be opened and shut like a book, as at *Fig.* 25. If they are placed upon any plane, in which there is a semi-circle divided into degrees, in such a manner that the point where the specula meet, is in the centre of the circle, and the edge of each speculum stands upon the diameter of the semi-circle, one image only will be visible, and there will appear two things, namely, a real one, without the specula, and another formed by reflection behind them,* and so on, as in the following table, where the first column shews the inclination of the specula, and the second the figure which is produced.

Angle of Specula.	*Effect produced.*
180°	One image and one object.
*120	Two images and one object.

Angle of Specula.	*Effect produced.*
90°	Four images.
*72	A pentagon and five forms.
60	A hexagon and six forms.
*51⅔	A heptagon and seven forms.
45	An octagon and eight forms.
*40	An enneagon and nine forms.
36	A decagon and ten forms.
*32 8/11	An endecagon and eleven forms.
30	A dodecagon and twelve forms.

And so on *ad infinitum*, the polygon formed by reflection having always as many sides as the number of times that the angle of the specula is contained in 360°.

Gigantic Meteorological Æolian Harp.

Captain Haas, of Basle, has designated by these an apparatus which emits of itself a variety of sounds during a change of weather. Since the year 1787, he had stretched above his garden fifteen iron wires, three hundred and twenty feet long, and at the distance of about two inches from one another: the largest wire was two lines in diameter, the smallest one line, and those of intermediate size one line and a half. They were situated towards the south, and are inclined 20° or 30° to the horizon, being stretched by means of rollers, properly arranged for the purpose. Whenever the weather changes, these wires sound with such loudness that it is impossible to go on with a concert in the house. The sounds sometimes resemble the hissing noise of water rapid in ebullition, sometimes that of an harmonicon, and sometimes that of a distant chime, or an organ.

The inventor of this curious apparatus is Mr. Ventau, provost at Burkli, not far from Basle. He sometimes shot at a mark from his window, and in order that he might not go to the mark at each shot, he attached to it a long iron wire to draw it to him

at pleasure. He remarked more than once that the wire sounded exactly an octave; and he found that every iron wire, stretched in a direction parallel to the sounds, emitted this tone at every change of weather.

A brass wire did not produce any sound, nor did an iron wire when it was stretched from east to west.

M. Dobereiner, of Jena, conceives that the phenomenon now described, is the effect of an electro-magnetic action; and he proposes to try if the brass wire would not sound when it communicates at its extremity with an energetic electrometer.

Action of Water on Glass.

Glass is most extensively used for vessels for containing both fluid and dry substances, which it is desirable to preserve in a state of purity, and it is believed to be capable of resisting the action of even strong chemical solvents. A most interesting memoir, by Mr. Griffiths, places this subject, however, in a very different view from that in which it has usually been regarded.

The inquiries of this ingenious chemist inform us, that glass possesses highly alkaline properties, and that they may be easily shewn by the usual tests. The alkali separates from glass by the action of pure water; it appears to be potash, and its evolution from the fragments of glass was much facilitated by the application of heat to the water. By long continued boiling in two or three successive portions of water, flint glass in fine powder lost about 7 per cent. of alkaline matter.

Though the greater part of the experiments were made on flint glass, it is not the only kind which affords alkali to water. Crown glass, plate glass, white enamel, and even the Newcastle green bottle glass, exhibit alkaline qualities when acted upon by pure water; and Reaumer's porcelain, which is made *from green bottle glass*, afforded like results.

Whether we consider these researches with to the glasses employed in the laboratory chemist, or to contain medicines, or for the inco able variety of purposes to which they are appl domestic affairs, it must be evident that the g so employed will be acted upon by water, and aided by other solvents, so as to remove the alk the glass to a certain depth in the surfaces in co with the solvent. In some cases, the alkaline ter may be of use in neutralizing a slight tend to acidity; but, in general, it must be injurious, particularly to chemical bodies.

Mr. Griffiths examined some specimens of tra parent and coloured ancient glass, and found them every case to contain more alkaline matter than a modern glass containing lead hitherto examined therefore it ceases to be a matter of surprise tha the specimens of ancient glass are so frequently found in a state of rapid decay.

The contact of ammoniacal, or decomposing animal matters, decomposes glass very rapidly. Stable windows, and bottles kept in such situations, often present a very beautiful iridescent appearance, sometimes inclining to a pearly, and sometimes to a metallic aspect, from the decomposition of the glass. Solution of potash acts rapidly on glass, and particularly at high temperatures; and it has been remarked, that flint glass bottles used for keeping solid carbonate of ammonia in, are invariably rendered more brittle, and pieces of glass sometimes fall out on a very slight motion of their contents.

Phantasmagoria.

In the optical deception called Phantasmagoria, the object increases in brightness as it diminishes in size, or as it seems to retire, till it finally verges into a luminous point; a mode of disappearance so unexpected as to destroy the illusion it is designed to produce. This defect Mr. William Ritchie pro-

poses to avoid by the following method, by which the disappearance of the objects may be rendered more in accordance with what is supposed to take place under the circumstances intended to be represented.

He proposes to supply the light by a portable gas lamp, with apparatus for increasing or diminishing the supply of gas to the burner at pleasure, which, by a peculiar stop cock, might very readily be accomplished. Then, by diminishing the light gradually, the brilliancy of the figure might be reduced as it retires, its lineaments would become shadowy and obscure, and at length vanish into thin air, as it is expected a phantom would do.

To measure the Focal Distance of a Globe of Water and of Glass.

Take a hollow globe of glass, or, instead of it, a thin round flask or decanter, and making a moderate round hole about an inch diameter, in a piece of brown paper, paste it on one side of the belly of the decanter; and having filled it with water, hold the covered side to the sun, that the perpendicular rays may pass through the middle of the water, and the emergent rays will be collected to a focus, whose nearest distance from the decanter will be equal to the semi-diameter of the belly of it; as will appear by receiving the rays upon a paper, held at that distance. That this effect is owing to the water, and not to the glass, will be evident by emptying the decanter; for the light that passes then through the hole, will then be as broad as the hole itself, at all distances of the paper from the decanter. If a similar experiment be tried, with a solid globe or ball of glass, the distance of the focus from the nearest part of the ball will be one quarter of its diameter.

To obtain exquisite Skeletons of small Animals.

Put any small subject, such as a mouse, frog, (if a bird strip it of its feathers,) in a box perforated with

a number of holes; let it be properly distended to prevent the parts from collapsing, or being crushed together by the pressure of the earth. Then place the box and its contents in an ant-hole; and in a few days it will have become an exquisitely beautiful and perfect skeleton by the ants having consumed every part of it except the bones and ligaments.

To prepare a Hortus Siccus, or Dry Garden.

1. First procure a strong oak-box of the same size and shape as those employed for packing up tin plates;

2. A quantity of fine sifted sand, sufficient to fill the box;

3. A considerable number of pieces of pliant paper, from one to four inches square; and

4. Some small flat leaden weights, and a few small bound books.

The plant is first to be cleared from the soil and decayed leaves, and then laid on the inside of one of the leaves of a sheet of common cap-paper. The upper leaves and flowers are next to be covered, when expanded, by pieces of the prepared paper, and one or two of the leaden weights placed on them. The remainder of the plant is now to be treated in a similar manner.

The weights ought now to be gently removed, and the other leaf of the sheet of paper folded over the opposite one, so as to contain the loose pieces of paper and plants between them. A book or two is now to be applied to the outside of the paper till the intended number of plants is thus prepared; when a box is to be filled with sand to the depth of an inch, one of the plants put in, and covered with sand sufficient to prevent the form of the plant from varying. The other plants may then be placed in succession, and likewise covered with a layer of sand, one inch thick between each; after which the whole is to be gently pressed down in a greater or less

degree, according to the tenderness or firmness of the plants.

The box is next to be carefully placed before a fire, one side being occasionally a little raised, as may be most convenient, the sides being alternately presented to the fire two or three times a day, or the whole may be put into an oven gently heated. In the course of two or three days the plants will be perfectly dry, when the sand ought to be taken out and put into another box; the plants should likewise be removed to sheets of writing paper.

Gravitating Power of the Sun and Planets.

The following table exhibits the relation of the densities, diameters, quantities of matter, and gravity on the surfaces of the sun and planets respectively.

Planets.	Densities.	Diameters.	Quantities of Matter.	Gravity on Surfaces.
Sun	0.25226	109.8	333928	27.7
Mercury	2.5833	0.4	0.16536	1.0333
Venus ...	1.024	0.9543	0.88993	0.9771
Earth ...	1	1	1	1
Mars ...	0.6563	0.5109	0.08752	0.3355
Jupiter...	0.20093	11.59	312.101	2.3287
Saturn ...	0.10349	9.812	97.762	1.0154
Georgian	0.21805	4.258	16.837	0.9285
Moon ...	0.6149	0.2727	0.01245	0.1677

An Improvement of the Galvanic Trough, to prevent the Cement from being melted when the Action is very powerful.

A gentleman of Tunbridge has found that considerable advantage arises from making galvanic troughs with glass partitions, for constructing galvanic batteries, on the principle of Volta's *couronne des tasses;* the superiority of which, he takes for granted, to be fully established. In troughs constructed on Mr. Wilkinson's plan, one material inconvenience is experienced: the increased action of the acid on the zinc plates, arising from their having the whole of their surfaces exposed to it, occasions so great an heat, as frequently to melt the cement, with which the wooden partitions of these troughs are coated. Glass partitions completely prevent the heat from having any bad effect. It is best to make them so much larger than the metallic plates, that a space of about half an inch may be left between the sides and bottom of the trough, and the extremities of the metallic plates. Common crown glass is well adapted for this purpose, if of thickness proportioned to the size of the partitions wanted, the upper edges of which should be ground very smooth. In batteries constructed on this plan the greatest intensity of excitation has been found to do no injury whatsoever to the cement.

How those who cannot Swim may Float if they fall into Water.

Mr. William Nicholson has published some very good directions for this object, the chief of which are, that when a person falls into water, who has not learned to swim, he should carefully avoid raising his hands above the water, and then by moving them under water, in any manner he chooses, his head will rise high enough to enable him to breathe

; if he moves his legs, as in the action of
ıg up stairs, more of his body will rise above
ater, which will allow him to use less exertion
his hands.
which we will add, that by throwing back the
ınd shoulders, so as to thrust out the chest to
eatest extent, and keeping it in that position,
ılume of air contained in the lungs will be so
increased, as to add very considerably to the
nce of the upper part of the body; this alone
enable some people to float without using any
n of their limbs.

thod of obtaining exact Copies of Inscriptions.

ɜ stone, or other matter, on which the inscrip-
ı cut, is to be first well washed and dried; then
printers' balls the surface is laid over with
ng ink, in the same manner as it is laid on
; one or more sheets of paper, according to
ze of the inscription, previously damped, are
aid over it, and the impression taken off by
ıg the paper with a clean printing ball, the
or a brush. Three or four copies should be
in this manner, as the fourth is usually the
perfect. As the inscription will be reversed
: paper, it may be read off right at the other
ıy holding the paper against the light. If the
ıtion is in relievo, the letters will be black;
ollow, the letters will be white, and the ground

ıtiful Figures in Sand, &c. produced by Sound.

as long been known that the agitations pro-
in the air by a sounding body may be sufficient
ite a second body placed even at a great dis-
from the first, provided, however, that both
able of producing exactly the same number
rations in the same time.

Dr. Savarb has been making experiments with stretched membranes, which, at the same time that the thickness are very inconsiderable, present large surfaces to the air, which puts them in motion. He took, for example, a circular piece of thin paper, or gold-beaters' skin, about ten inches in diameter, and carefully stretched it by its circumference upon the edge of a large glass vase; on strewing the surface, placed horizontally, with fine and dry sand, and bringing a plate of glass in vibration within the distance of nine or ten inches, and parallel with the surface, the membrane entered into motion, and the sand assumed figures, which were sometimes perfectly regular, and which often formed themselves with so much rapidity, that his eye had scarcely time to perceive the circumstances which accompanied the transformation of the light layer of sand into a greater or less number of quiescent lines. Various figures were thus obtained—stars, with four, six, ten, or more radiations, circles, &c. When the plate, instead of being parallel, was placed perpendicularly to one of the diameters of the surface, the sand formed itself into a system of quiescent lines, which generally were parallel with one another: one of these lines passed always through the centre of the membrane, and was contained in the plane which passed through the face of the plate; the direction of the motion consequently continually changed with the direction of the vibrating plate. If, instead of holding the plate in the direction of perpendicular to that of the surface, it was inclined; at every degree of inclination the phenomena obtained were different, and the lines traced by the sand continually modified themselves differently, although the number of vibrations remained the same.

The tones of the flute, trumpet, musical glasses, &c. or of the voice, produced the same results as a vibrating plate. When the tones were successively varied, for example, when a very slow air was performed on the flute, at about nine or ten inches dis-

from the membrane, the sand was agitated, aced lines, the combinations of which inces- varied with the sound produced. Stringed ments were not so well calculated to produce effects.

ese experiments were varied in a number of by employing membranes, of which the di- ons, nature, and tension, as well as form, were nt: they always, however, presented analo- esults.

Frozen Mercury.

ie idea of the very low temperature of frozen ry may be derived from the circumstance, a lump of it be dropped into a small quantity er at the boiling point, it will abstract the with such rapidity, that the mercury will tly become fluid, and the hot water will at ne moment be converted to ice.

sy and secure Method of Secret Correspondence.

pretensions of the following mode of secret g are simplicity, impossibility of detection, ie capability of multiplying its keys to infi-

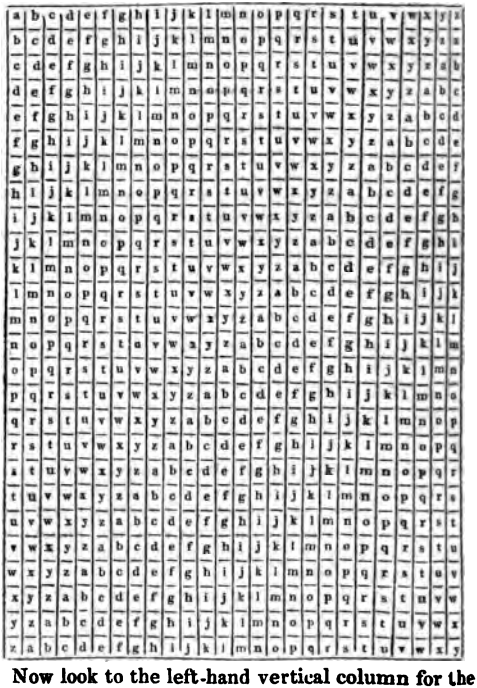
the key for each of the correspondents be a f poetry, or the name of some memorable or place, that cannot be forgotten; and let ll be provided with a copy of the following hich may be printed, as it matters not into hands it falls.

en the despatch is composed, write the key- ce underneath the text, letter for letter, re- it as often as it may be necessary. For exam- ppose the key-sentence to be "Sir Humphry " and the secret clause of the despatch to b- ract the negociation as much as possible

These, when written as above directed, will stand thus:

P r o t r a c t t h e n e g o c i a t i o n a s m u c h
S i r h u m p h r y d a v y s i r h u m p h r y d a v y

a s p o s s i b l e.
s i r h u m p h r y.



Now look to the left-hand vertical column for the *first* letter of the text, P, and in the upper hori-

al column for the corresponding letter of the *s*; where these columns meet, *h* will be found, :h write down. Proceed in this manner for the esentation of the next letter *r*, (that is, at the tion of the columns *r* and *i*), which will be *s*; so on through the whole of the paragraph. It then appear as follows:

xfalmra kfh nsegkxhnudu rq puxf se gomexioe.

inverted process for decyphering needs no ex- ation.

Acoustical Alphabet.

r varying the order of arrangement, the whole abet may readily be rung on three bells; and e being formed into sentences by short pauses een each word, will fully serve for distant con- ation. For musical instruments, it is merely ging keys for bells, and the same purpose may nswered without the trouble of forming changes so small a number of fixed tones. A table is ined, by the use of which a combination of three is made to express the whole alphabet:

represented by	111	O	is represented by	222
,,	112	P	,,	223
,,	113	Q	,,	231
,,	121	R	,,	232
,,	122	S	,,	233
,,	123	T	,,	311
,,	131	V	,,	312
,,	132	U	,,	313
,,	133	W	,,	321
,,	211	X	,,	322
,,	212	Y	,,	323
,,	213	Z	,,	333
,,	221			

Cohesion of Water.

If a glass be filled to the brim with wat several small articles, as counters for in dropped in, what is the reason the water dc run over the brim of the glass?

It is the natural quality of all dry substa resist water in a small degree; hence the top glass being dry, the counters not being so gre overcome the resistance, and slipped in with a hand, the water will rise above the dry edge out running over, till so many are put in as t the weight of the heaped up part to overcon repulsion of the dry edge. The truth of th be proved by dipping your finger in the and wetting the edge of the cup with it, upon all the water which is above the rim of the c run over.

Patent Crystallo Ceramie, or Glass Incrustati

Mr. Pellat's patent process for ornamenting called by its inventor *Crystallo Ceramie*, bids f form an important era in the art of glass-m By this process, ornaments of any descriptio be introduced into the glass, so as to become per imperishable. The substance of which the composed is less fusible than glass, and at the time susceptible of contraction or expansion, latter desideratum is a matter of considerabl portance, as, in the course of manufacture, the varies both in the temperature and dimension may previously be formed into any device or f by either moulding or modelling, and may be ed with metallic colours, which are fixed by sure to a melting heat. The ornaments are duced into the body of the glass while hot, by means the air is effectually excluded, the con *tion being* actually incorporated with the glass

A most important advantage to be derived from this elegant invention, respects the preservation of dates and inscriptions. Casts of medals and coins present no equal security perpetuating them. Had this art been known to the ancients, it would have preserved to us many interesting memorials. The inscriptions, when once incrusted in a solid block of crystal, like the fly in amber, will effectually resist for ages the destructive action of the atmosphere.

Hero's Altar.

The great expansive force of steam was known at a very early period, and the engine contrived by Hero may be considered a sufficient illustration of this fact. The elastic power of air was also generally understood, and reference to *Fig.* 26, will furnish a picturesque view of the application of this knowledge, to aid the purpose of idolatrous superstition described by the same philosopher, who was one of the builders of the church (now the mosque) of Saint Sophia.

The altar A is supported by the base B, a communication being made by the dotted aperture E. The lower vessel being filled with any inflammable fluid, the application of a few half extinguished embers to the top of the altar will expand the air contained within it, and, pressing on the surface of the fluid, it must ascend the tube C. The vase supported by the priest at D will then overflow, and the fuel will appear to blaze by super-human aid.

A Defence against Fire.

Professor Palmer, of Hamburgh, has lately discovered a means by which all inflammable matters, such as wood, paper, linen, &c. cannot only be secured from burning, but also be speedily extinguished when on fire. These means consist in a

powder composed of one ounce of sulphur, one ounce of red ochre, and six ounces of copperas water. To render wood incombustible, it is first daubed over with cabinet-maker's glue, after which the powder is strewed over it; and this operation, when the wood becomes dry, is three or four times repeated. When the powder is to be applied to linen or paper, plain water is employed in the room of glue: in other respects the process is the same, with this difference only, that the operation is performed only once or twice. When the powder is used for articles already on fire, two ounces are sufficient to extinguish a square foot of surface. Professor Palmer intends to publish a full account of his invention, and of the different methods of using it, and to show how at the time of large conflagrations it may be employed to most advantage to save the lives of men and valuable articles.

Method of preventing Iron and Steel from Rusting.

C. Conte has found out a method of preventing the oxydation of iron and steel, or, to speak in language more generally understood, to prevent iron and steel from rusting. This method consists in mixing with fat, oil varnish, a half at least, or rather four-fifths, of well rectified spirits of turpentine. This varnish is applied slightly, and in an equal manner, by means of a sponge; after which the article is suffered to dry in a place sheltered from dust. Articles varnished in this manner, it is said, will retain their metallic brilliancy, and never contract any spots of rust. This varnish may be applied also to copper, of which it preserves the polish, and brightens the colour. It may be employed in particular with advantage, for preserving from alteration philosophical instruments, which, in the course of experiments, are brought into contact with water, and by those means are liable to lose their splendor, *and to* become tarnished.

Phosphorescence of Wood.

Dr. Carradori, in a paper on the phosphorescence of wood, asserts that phosphoric wood acquires by putrefaction the property of attracting and absorbing light, and of retaining it mechanically. To make it shine, it is sufficient to expose it for some time to the sun. A bit of wood, which the author examined, continued to shine under oil for two whole days. In that situation, says Dr. Carradori, it was not in contact with oxygen gas.

Botanical Experiment.

A singular and ingenious method of multiplying the tongue-leaved eucomis, or futillary, is described in Professor Hedwig's collection of memoirs and observations on subjects of Botany and Economy. This futillary is called by Lamarck, Basile a epi couronne. When this beautiful plant of the lily kind is in full flower and vigour, the flowers, leaves, and the upper part of the bulb must be cut, and wrapped up in several folds of sized writing paper, so that the whole be exactly covered. They are then to be moderately compressed between two pieces of board; and at the end of some months several small bulbs will be seen formed at the lower extremity. I cultivate, (says C. Willeret, who has made known the above observation,) this charming unilobed plant in the National Botanic Garden at Nancy. It requires to be kept during winter in the hot-house.

New mode of exhibiting Prince Rupert's Drops.

A very good method of exhibiting the force exerted by those singular pieces of glass on being broken, is, to immerse them in a phial, or a tall glass, filled with water: on breaking off the end with a pair of pincers, the body of the bulb is rent with such force as im-

fallibly to break the vessel; even a stout wine bottle may be torn asunder by them in this way.

Orange Gas.

In making some experiments in fluoric acid, M. Unverdorben, a German chemist, obtained a gas from a mixture of fluor-spar and chromate of lead, with fuming sulphuric acid, which has some singular properties.

The experiments were repeated by Professor Berzelius, who found that it succeeded quite as well when common concentrated sulphuric acid was used. The gas was collected over mercury, in glass flasks, lined with melted resin, and it is of an orange red colour. It gradually destroys the resin, and penetrates to the glass, which it decomposes; when ammoniacal gas is introduced, it burns with explosion. Water dissolves the orange gas, and yields an orange-coloured liquid, which being evaporated to dryness in a platina dish, leaves us a residue of pure chromic acid, the fluoric acid volatilizing entirely. This is the only known method which gives pure chromic acid.

If the gas be received in a platina vessel of some depth, of which the sides have been slightly wetted, and into the bottom of which the gas is made to descend, the water begins to absorb the gas, and, soon after, crystals of a fine red colour, are seen to form themselves round the opening of the metal tube which conveys the gas, and the crystals collect so as to fill the vessel. The matter deposited has the appearance of red snow, and consists of crystallized chromic acid. These crystals have a curious property. If they be heated to redness in a platina dish, they begin first to melt, and afterwards, with a slight explosion, accompanied by a flash of light, they decompose into oxygen gas, and the green oxide of chrome.

In distilling chromate of lead with chloride of so-

dium, a gas similar to the preceding is obtained. It contains chrome combined with chlorine in such proportions, that the water, by its decomposition, causes the formation of hydrodoric and chromic acids. The gas is red, and may be collected over mercury, but it is very much charged with chlorine when the preparation is effected by means of common concentrated sulphuric acid, whose water of combination destroys a certain quantity of the gas.

Windsor Mineral Waters.

There are two springs in the Great Park at Windsor, which afford mineral water, and they have lately been much frequented; hence an account of their nature may not be unacceptable to the reader.

These waters have been examined by Mr. Brande, from whose paper it appears that the water of one of the springs contains a larger proportion of saline matter than the other; but the nature of the saline matter seems to be the same in both springs.

Their taste is salt, and slightly bitter, without the smallest admixture of chalybeate flavour. The specific gravity of the stronger water is 1.0104, that of the weaker 1.0077. Of the former, 7073 grains of water afforded, on evaporation, 88 grains of dry saline residue; of the latter, 7054 grains of water yielded 65 grains of residue.

The 88 grains from the stronger water consisted of

Sulphuric acid	33.00	grains.
Muriatic acid	21.00	„
Carbonic acid	.98	„
Magnesia	21.25	„
Soda	10.52	„
Lime	1.25	„
	88.00	

And Mr. Brande considers these constituents to exist in the water in the following combinations:—

Sulphate of magnesia ..	38.0	grains.
Muriate of magnesia	24.5	,,
Common salt	9.3	,,
Sulphate of soda	10.8	,,
Sulphate of lime	3.0	,,
Carbonate of soda	2.4	,,
	88.0	

It is a property of this water when boiled, to throw down carbonate of magnesia; and it appears, from Mr. Brande's trials, that the existence of carbonate of soda is compatible with the other earthly salts in a cold and dilute solution only.

Improved Drawing Tablets.

The extra stout drawing-boards, or card-boards, as they are usually called, are liable to many defects. They are made by pasting several sheets of paper together, in the manner of common pasteboard, and are then pressed and rolled. In consequence of this process, it frequently happens that a small portion of paste is left on the surface, which, escaping observation at first, causes injury when a drawing is made on the board. In drawing, also, if frequent re-wetting on a particular part be necessary, the paste sometimes gives way, the sheets separate, and blisters rise. It has been remarked too, that drawings made on such boards, and hung up in rooms where fires are seldom made, spoil, from the tendency of the paste to mould or mildew. Another defect is, a hollow or spongy texture, arising from the indiscriminate mixture of linen and cotton fibres in the pulp of the paper, and another, the deleterious effect of bleaching by oxymuriate of lime, a process which, though it

makes the paper beautiful in appearance, leaves a small portion of muriatic acid, which speedily destroys the fine and delicate tints laid upon it.

In consequence of these defects, Mr. Steart, of the Montalt paper-mills, near Bath, has submitted to the Society of Arts specimens of drawing-boards, which he calls Lino-Stereo Tablets, entirely free from these defects, and which have been found to answer every trial made of them. The only material used in their manufacture is the best and purest white linen rags, all muslins, calicoes, and every other cotton article being rejected: and they are not composed of several sheets, but are moulded from the pulp of any required thickness of one entire mass, so that no separation of their parts can take place, either by wetting or mouldiness. These tablets are made with either a rough or a smooth face, the former for drawings, made with pencil, chalk, or crayon, the latter for paintings in water-colours, or other delicate works. They are also tinted of various shades of drab-gray, sand-colour, &c., the pulp being dyed in the vat before it is made into doublets.

Easily-acquired Secret Character.

Mr. Allsop describes, in a letter to the Editor of the Technical Repository, a mode of secret writing which he has long used for making private notes and memorandums. It is simply to substitute the preceding or succeeding letter for the one used; thus,—for the letter *a*, substitute *b*, for *b*, *c*, and so on. The following is a specimen:—

Sir, Among the numberless inventions adopted for secret.

Sir, Bnpoh uif ovncfsmftt jowfoujpot bepqufe gps tfdsfu.

Always addressing and concluding the letter in the

usual manner to prevent a discovery, or giving a key to the cipher.

Apparatus for exhibiting the Simultaneous Rotation of two Voltaic conducting Wires round the opposite Poles of Magnets.

An apparatus of this description was constructed some time ago by Mr. T. Griffiths, and shewn at the London Institution during a course of lectures on Electro-magnetism, delivered in 1823, by Professor Brande. It consists of two copper wires, suspended in the usual manner, and dipping into a shallow vessel of mercury, in which are placed two bar magnets with their opposite poles arranged above its surface. The connexion being established between the battery and the apparatus, the wires revolve round the magnets simultaneously, but in opposite directions. In this form of apparatus the necessity of stopping the single rotation, to exhibit its contrary movement by reversing the magnet, is avoided.

Candle Bomb.

Take a small glass bubble, having a neck about an inch long, with a very slender bore, by means of which introduce a small quantity of water, and then close up the orifice. Put the stalk of the bubble through the wick of a lighted candle, the vicinity of the flame soon rarefies the water into steam, by the elasticity of which the glass is broken with a loud report.

Of the Combinations of the Cards.

The tables here given are the basis of many recreations, as well on numbers, letters, and other subjects, as on the cards: and the effect is good, as that which seems to prevent collusion, that is, the

shuffling of the cards is, on the contrary, the cause from whence it proceeds.

It is a matter of indifference what numbers are made use of in forming these tables: we shall here confine ourselves to such as are applicable to the subsequent recreations; any one may construct them in such manner as is agreeable to the purpose he intends they shall answer.

To make them, for example, correspond to the nine digits and a cypher, there must be ten cards, and at the top of nine of them must be written one of the digits, and on the tenth, a cypher; these cards must be placed upon each other in the regular order, the number 1 being on the first, and the cypher at bottom; you then take the cards in your left hand, and, taking off the two top cards, 1 and 2, you place the two following, 3 and 4, upon them, and, under those four cards, the three following, 5, 6, and 7: at the top you put the cards 8 and 9, and, at the bottom, the card marked 0, constantly placing, in succession, 2 at top and 3 at the bottom, and they will then be in the following order:

8.9..3.4..1.2..5.6.7..0

If you shuffle them a second time, in the same manner, they will stand in this order:

6.7..3.4..8.9..1.2.3..0

Thus, at every new shuffle they will have a different order, as expressed in the following lines:

The 3rd	shuffle ..	2.5.3.4.6.7.8.9.1.0
4th	„	9.1.3.4.2.5.6.7.8.0
5th	„	7.8.3.4.9.1.2.4.6.0
6th	„	5.6.3.4.7.8.9.1.2.0
7th	„	1.2.3.4.5.6.7.8.9.0

It is a remarkable property of this number, that the cards return to the order in which they were first placed, after a number of shuffles, which, added to the number of columns that never change the order, is equal to the number of cards: thus, the

number of shuffles is 7, and the number of colum in which the cards marked 3, 4, &c. never chan their places is 3, which are equal to 10, the numl of the cards: this property is not common to numbers, the cards sometimes returning to the fi order in less number, and sometimes in a great number of shuffles than that of the cards.

Tables of Combinations constructed on the foregoin Principles.

TABLE 1.—For ten numbers.

Order before shuffling.	After 1st shuffle.	After 2nd shuffle.	After 3r shuffle.
1	8	6	2
2	9	7	5
3	3	3	3
4	4	4	4
5	1	8	6
6	2	9	7
7	5	1	8
8	6	2	9
9	7	5	1
0	0	0	0

TABLE 2.—For twenty-four numbers.

1	23	21	17
2	24	22	20
3	18	12	2
4	19	15	7
5	13	5	13
6	14	6	14
7	8	9	3
8	9	3	18
9	3	18	12
10	4	19	15

Order before shuffling.	After 1st shuffle.	fter 2nd shuffle.	After 3rd shuffle.
11	1	23	21
12	2	24	22
13	5	13	5
14	6	14	6
15	7	8	9
16	10	4	19
17	11	2	23
18	12	1	24
19	15	7	8
20	16	10	4
21	17	11	1
22	20	16	10
23	21	17	11
24	22	20	16

TABLE 3.—For twenty-seven Numbers.

1	23	21	17
2	24	22	20
3	18	12	2
4	19	15	7
5	13	5	13
6	14	6	14
7	8	9	3
8	9	3	18
9	3	18	12
10	4	19	16
11	1	23	21
12	2	24	22
13	5	13	5
14	6	14	6
15	7	8	9
16	10	4	19
17	11	1	23
18	12	2	24

Order before shuffling.	After 1st shuffle.	After 2nd shuffle.	After 3rd shuffle.
19	15	7	8
20	16	10	4
21	17	11	1
22	20	16	10
23	21	17	11
24	22	20	16
25	25	25	25
26	26	26	26
27	27	27	27

The Arithmetical Triangle, or Table for Combinations.

						A						
1	Rank					1	B					
2						2	.	1				
3						3	.	3	.	1		
4					4	.	6	.	4	.	1	
5					5	.	10	.	10	.	5	. 1
6				6	.	15	.	20	.	15	.	6 . 1
7				7	.	21	.	35	.	35	.	21 . 7 . 1
8			8	.	28	.	56	.	70	.	56	. 28 . 8 . 1
9		9	.	36	.	84	.	126	.	126	.	84 . 36 . 9 . 1
10		10	.	45	.	120	.	210	.	252	.	210 . 120 . 45 . 10 . 1
11		11	.	55	.	165	.	330	.	462	.	462 . 330 . 165 . 55 . 11 . 1
12	*a*	12	.	66	.	220	.	425	.	792	.	924 . 792 . 495 . 220 . 66 . 12 . 1

The construction of this table is very simple. The line A*a* consists of the first twelve numbers. The line A *b* consists every where of units; and second term 3, of the line B *c*, is composed of the two terms 1 and 2 in the preceding rank; the third term 6, in that line, is formed of the two terms 3 and 3 in the preceding rank; and so of the rest, every term after the first being composed of the two next terms in the preceding rank: and by the same method it may be continued to any number of ranks. To find by this table how often any number

f things can be combined in another number under 3, as suppose 5 cards out of 8: in the eighth rank ook for the fifth term, which is 56, and that is the umber required.

Example 1.

To find how many different sounds may be produced by striking on a harpsichord for two or more f the seven natural notes at the same time.

.	The combination of 2 in 7, by the foregoing triangle, are	21
.	The combinations of 3 in 7, are	35
.	„ „ 4 in 7, are	35
.	„ „ 5 are	21
.	„ „ 6 are	7
.	The seven notes all together once	1

Therefore the number of all the sounds will be 120.

Example 2.

A person has twelve different sorts of flowers, a arge number of each sort: he is desirous of setting hem in beds in his parterre: 6 in some, 7 in others, nd 8 in others; so as to have the greatest variety ossible, the flowers in no two beds to be the same. To find how many beds he must have.

.	The combinations of 6 in 12 by the last rank of the triangle, are	924
.	The combinations of 7 in 12, are	792
.	The combinations of 8 in 12, are	495
	Therefore the number of beds must be ..	2211

Electric Chime.

Fig. 27 represents the arrangement of an electric chime. For this purpose, a series of about 1600 groups of zinc, silver, and paper disks, are disposed n two columns, separately insulated in a vertic position: the positive end of one column is pl

lowest, and the negative end of the other, their upper extremities being connected so as to form in effect one series, having at each of its extremities a small bell; between the bells a small ball is suspended by a thread of raw silk, so as to hang at an equal and very small distance from each of them if unelectrified. The action of the column occasions this ball to vibrate between the bells and produce an electric chime, in which the variable action of the instrument at different times is indicated by an increased or diminished velocity of ringing. There is a circular groove in the base of the instrument which receives the rim of a glass shade, by which dust and moisture are prevented from impeding its action.

Rotation of Glass Tubes before a Fire.

A most remarkable phenomenon is produced in glass tubes placed in certain circumstances. When they are laid before a fire in a horizontal position, having their extremities properly supported, they acquire a rotatory motion round their axis, and also a progressive motion towards the fire. When the progressive motion of the tubes towards the fire is stopped by any obstacle, their rotation still continues. When the tubes are placed in a nearly upright posture, leaning to the right hand, the motion will be from east to west; but if they lean to the left hand, their motion will be from west to east; and the nearer they are placed to a perfectly upright posture, the less will the motion be either way.

If the tube is placed horizontally on a glass plane, the fragment, for instance, of coach-window glass, instead of moving towards the fire, it will move from it, and about its axis in a contrary direction to what it had done before; nay, it will recede from the fire, and move a little up hill, when the plane inclines towards the fire.

The experiment succeeds best with tubes about

twenty or twenty-two inches long, which have in each end a pretty strong pin fixed in cork, for an axis.

Singular Properties of Glass.

When glass is suddenly cooled, it becomes exceedingly brittle; and this brittleness is sometimes attended with very surprising phenomena. Hollow balls made of unannealed glass, with a small hole in them, will fly to pieces by the heat of the hand only, if the hole by which the internal and external air communicate be stopped with a finger. Some vessels, however, made of such unannealed glass, have been discovered, which have the remarkable property of resisting very hard strokes given from without, though they shiver to pieces by the shocks received from the fall of very light and minute bodies dropped into their cavities. The glasses may be made of any shape: it is only necessary that their bottom be thicker than their sides. The thicker the bottom is, the easier the glasses break. One whose bottom is three fingers' breadth in thickness flies with as much ease as the thinnest glass. Some of these vessels have been tried with strokes of a mallet sufficient to drive a nail into wood, and have not been broken. They have also resisted the shock of heavy bodies let fall into them from the height of two or three feet, as musket balls, pieces of iron, &c. &c.; yet, taking a small shiver of flint, the size of a pea, and letting it fall only from the height of three inches, will occasion the glass to fly, sometimes at the very moment of the shock, sometimes in two seconds; a bit of flint, no larger than a grain, dropped into several glasses successively, though it did not immediately break them, yet, when set by, they all flew in less than three quarters of an hour.

These experiments were made before the Royal Society; and succeeded equally when the glasses were held in the hand, when they were rested on a

pillow, put in water, or filled with water. It is also remarkable, that the glasses broke upon having their bottoms slightly rubbed with the finger, though some of them did not fly till half-an-hour after the rubbing.

From the three Primary Colours, red, yellow, and blue, to produce the other Prismatic Colours, and all the intermediate ones.

Provide three panes of glass of about five inches square, and divide each of them into five equal parts. Paint lightly three sheets of very thin paper, one blue, another yellow, the third red; then paste on one of the glasses five pieces of the red paper, one of which must cover the whole glass, the second only the four lower divisions, the third the three lower, the fourth the two lowest, and the fifth the last division only. On the other glasses, the blue and yellow papers must be pasted in like manner. Have also a box of about six inches long, of the same depth and width as the glasses, black inside; let one end be open, and in the opposite end a hole large enough to see the glasses completely. It must also open at the top, that the glasses may be placed in it conveniently.

When you have put any one of these glasses in the box, and the open end is turned toward the sun, you will see five distinct shades of the colour it contains. If you place the blue and yellow glasses together, in a similar direction, you will see five shades of green distinctly formed. When the blue and red glasses are placed, a bright violet will be produced: and by the red and yellow, the several shades of orange.

If, instead of placing these glasses in a similar direction, you reverse them, and place the side of the yellow glass by the top of the blue, you will have all the various greens that are produced by nature; if the blue and red glasses are similarly

placed, you will have all the possible varieties of purples, violets, &c.; and, lastly, if the red and orange glasses be so placed, there will be all the intermediate colours, as the marygold, aurora, &c.

Several Letters that contain no meaning, being written upon Cards, to make them, after they have been twice shuffled, give an answer to a question that shall be proposed: as, for example, What is Love?

Let twenty-four letters be written on as many cards, which, after they have been twice shuffled, shall give the following answer:

A Dream of Joy, that soon is o'er.

First, write one of the letters in that line on each of the cards, (these letters should be written in capitals in one of the corners of each card, that the words may be easily legible when the cards are spread open;) then write the answer on a paper, and assign one of the twenty-four first numbers to each card, in the following order:

A DREAM OF JOY THAT SOON IS O'ER.
1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24

Next, write on another paper a line of numbers, from 1 to 24, and looking in the table for twenty-four combinations, you will see that the first number after the second shuffle is 21, therefore the card that has the first letter of the answer, which is A, must be placed against that number in the line of numbers you have just made; (for the same reason, if you would have the answer after one shuffle, the cards must be placed according to the first column of the table; or if after three shuffles, according to the third column;) in like manner, the number 22 being the second of the same column, indicates that the card which answers to the second letter, D, of the answer, must be placed against that number; and so of the rest; the cards will then stand in the following order:

O O F S A M N T O I S R H A E O' E J O R A D Y T
1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24

From whence it follows, that, after these cards have been twice shuffled, they must infallibly stand in the order of the letters in the answer.

You should have several questions, with their answers, consisting of twenty-four letters, written on cards; these cards should be put in cases, and numbered, that you may know to which question each answer belongs; you then present the questions, and when any one of them is chosen, you pull out the case that contains the answer, and shewing that the letters written on them make no sense, you then shuffle them, and the answer becomes obvious.

On the Cause of regular Figures, formed by Hoar-Frost on Windows.

The following are among the principal causes of this curious phenomenon. 1. The natural force of crystallization. 2. The necessity of the hoar-frost extending itself along a plane surface, which retains the QUAQUA-VERSUS tendency of crystallization. 3. The numerous and varied resistances presented by the surface of the glass. 4. The imperfect and irregular conducting power of the glass, which is apt to produce in the vapours curvilineal motions, at the instant preceding their congelation. By placing a small copper disc on the outside of one of the panes of glass, it will be found that the corresponding part of the glass will always be free from hoar-frost.

On the Apparent Direction of the Eyes in a Portrait.

Dr. Wollaston observes, that when we consider the precision with which we commonly judge whether the eyes of another person are fixed upon ourselves, it is surprising that the grounds of such judgment are not distinctly known, and that most persons, in attempting to explain the subject, would

overlook some of the circumstances by which they are generally guided.

Dr. W. adverts to the influence of the form of the iris, as announcing the direction of the eye in portraits, and to that of the variable portion of the white shewn when the eye is variously directed, in living persons. He remarks, however, that even in real eyes we are not guided by this circumstance alone, but are unconsciously aided by the concurrent position of the face; and the apparent position of the eyes is powerfully influenced by that of the adjacent parts of the face, especially those which are most prominent; and these considerations are not limited in their application merely to cases of lateral turn of the eyes or face, but the same principles also apply to instances of moderate inclination of the face upwards or downwards; for when the face is directed downwards, the eyes that look at us must be turned upwards, from the position of the face to which they belong; and if to eyes so drawn an upward cast of features be substituted for the former, the eyes immediately look above us. From these details, the author concludes that the apparent direction of the eyes to or from the spectator depends upon the balance of two circumstances combined in the same representation; namely, 1. The general position of the face presented to the spectator. 2. The turn of the eyes from that position; and thence proceeds to examine why, if the eyes of a portrait look at the spectator placed in front of the picture, they appear to follow him in every other direction. When two objects are seen on the ground at different distances from us in the same direction, one appears, and must be represented, exactly above the other, so that a vertical plane from the eye would pass through them: and since such a line will be seen upright, however far we move to one side, it follows that the same objects still seem to be in a line with us, exactly as in the front view, seeming, as we move, to turn from their first direction.

In portraits, the permanence of direction, with reference to the spectator, and corresponding change of its apparent position in space when he moves to either side, depends upon the same principles. The nose drawn in front, with its central line upright, continues directed to the spectator, though viewed obliquely; or, if the right side of the nose is represented, it must appear directed to the right of the spectator in all situations; and eyes that turn in a due degree from that direction toward the spectator, so as to look at him when viewed in front, will continue to do so when viewed obliquely.

Method of taking very beautiful Impressions from Leaves.

Prepare two balls of smooth kid or chamois leather, stuffed with wool; moisten them with linseed oil; then take as much *dry* finely powdered colour which *will* rub, as will lay on the point of a penknife, and spread it over the balls: rub it in with a little more oil, till they are smooth, and free from knots. Take any fresh-gathered leaf, (those whose veins are most prominent are best adapted for the purpose,) and place it between the balls, till every part of it is coloured: lay it between two pieces of paper, and press it lightly. The under side of the leaf will give the impression.

Very elegant borders, taken off on satin, for ladies' dresses, may thus be procured; also embellishments for hand screens, and various ornamental works.

To marble Books or Paper.

Dissolve four ounces of gum arabic in two quarts of fair water: then provide several colours mixed with water in pots or shells, and, with pencils peculiar to each colour, sprinkle them, by way of intermixture, upon the gum-water, which must be put into

a trough, or some broad vessel; then with a stick curl them, or draw them out in streaks, to the greatest variety. Having done this, hold your book close together, and only dip the edges in, on the top of the water and colours, very lightly; which done, take them off, and the plain impressions of the colours in mixture will be upon the leaves.

Marbling books on the covers is performed by forming clouds with aquafortis, or spirit of vitriol mixed with ink, and afterwards glazing the covers.

Musical Glasses.

The advantages of the musical glasses are, that the tones are incomparably sweet beyond those of any other instrument; that they may be swelled and softened at pleasure, by stronger or weaker pressures of the finger, and continued to any length; and that the instrument being once well tuned never again wants tuning. The following is a description of it.

The glasses are blown as nearly as possible in the form of hemispheres, each having a stem by which it is fixed into a box or table. The number employed is sometimes 37, which are sufficient for the three octaves with all their semitones. A much larger number are occasionally used, but then two persons must play on them. The number usually employed is 17.

The glasses are to be tuned by diminishing the thickness of those that are too sharp. This is done by grinding them round, from the neck towards the brim, the breadth of one or two inches, as may be required; often trying the glass by a well-tuned harpsichord, comparing the note drawn from the glass by your finger with the note you want, as sounded by that string of the harpsichord. Much care is necessary, because, if you go below your required tone, there is no sharpening it again, but by grinding somewhat off the brim, which will afterwards require polishing.

When the glasses are not ground to the req tone, the desired effect is obtained by putting into them, more or less, as each note requires; mark each glass with a diamond or paint, wh the proper height.

The glasses are played upon with the n finger of each hand, which should be a little s in water, and *entirely* free from soil; sometin little fine chalk, or lemon juice in the water which the fingers are moistened, is useful to them bring out the tones more readily. The are best drawn out when the fingers turn *fro to*, you.

To distinguish the glasses more readily b eye, they are sometimes painted within side semi-tones white, the other notes of the with the seven prismatic colours: viz. C, re orange; E, yellow; F, green; G, blue; A, in B, purple; and C, red again; so that the gla the same colour (the white excepted) are s octaves to each other.

Vegetable Galvanic Pile.

A galvanic pile has been constructed by a tific gentleman, entirely of vegetable subst For this purpose, he cut discs of horse-radis beet-root, of two inches in diameter. He the pared equal discs of walnut-tree wood, which raised at their edges, to contain a little solut acidulous tartrate of potash in vinegar, in they had been previously boiled, to free the from rosin. Sixty pairs of discs were emplo the following order; viz. horse-radish, bee discs of wood. The spinal marrow of a pr frog was connected with the pile, by means of of *cochlearia;* the muscles of the frog were con with the top of the pile by means of a doubl of grey paper, wetted with vinegar, and, as o this circuit was completed, contortions were e in the animal.

Value of Charcoal.

In domestic economy, charcoal is invaluable. From its property of retarding putrefaction, it surpasses, as a preserver of meat, any thing we know of. Game, or any kind of animal food that has been over-kept, will be rendered perfectly sweet and wholesome by covering it with a few pieces of fresh-burnt charcoal; or, if it be far gone, boiling it for some minutes in water, with a few ounces of such charcoal, will effectually purify it.

Pure Flame.

Hydrogen gas furnishes the purest flame that can be exhibited; for the flame of bodies that emit much light derive that power from solid bodies intensely ignited, and diffused through them, and which, in ordinary flames, as of gas, tallow, wax, oil, &c. consists of finely divided charcoal.

Extreme Tenuity.

The thinnest substance ever observed is the aqeous film of the soap bubble previous to bursting; yet it is capable of reflecting a faint image of a candle, or the sun. Hence its thickness must correspond with what Sir Isaac Newton calls the *beginning of black*, which appears in water at the thickness of the $\frac{1}{178000}$th part of an inch.

To protect Boilers from Incrustation.

One per cent. of potatoes to the bulk of water is put into the boiler of the steam-engine, to prevent the cohesion of the precipitated calcareous salts, (selenite, or carbonate of lime.) The boiler is emptied once a month, and new potatoes added. This has long

been practised in England, but only recei
France.

Optical Tadpole.

Make with ink, on white paper, a very black
about half an inch in diameter, with a tail abo
inch in length, so as to resemble a tadpole:
steadfastly for a minute on the centre of this
and, on moving the eye a little, the figure of
tadpole will be seen on the white part of the pa
which figure of the tadpole will appear more lu
nous than the other part of the white paper; wh
can only be explained by supposing that part of
retina, on which the tadpole was delineated, to ha
become more sensible to light than the other pa
of it which were exposed to the white paper; a
not from any idea of mechanical impression or ch
mical combination of light with the retina.

Restoration of the White in Painting.

M. Thenard has lately applied his oxygenated
water with great success to the arts. It is constant
ly happening in paintings, where the white used i
prepared from lead, that sulphurous vapours change
the tint, and render it brown or black. Paintings o
the first masters are frequently injured in conse
quence of this effect, being blotted, as it were, with
spots of colour, which spoil the effect. An artist
at Paris, who possessed a design of Raphaël's thus
disfigured, and who was too careful of the origina
work to re-paint the places, applied to M. Thenard
for chemical assistance. That chemist, during his
attempts, remembering the effect of oxygenated
water in converting the black sulphuret of lead into
a white sulphate, sent some water, very slightly oxy
genated, to the artist, who by applying it with a
pencil, instantly removed the spots, and restored the
white. The fluid was so weak as to contain not
more than five or six times its volume of oxygen

and had no taste. Paper coloured by a slight tint of bistre was not at all altered by it.

Electrical Experiment.

The following experiment is described by Professor Moll. Place a thin piece of tin-foil vertically between two horizontal and insulated rods of brass, each terminated by a knob, and distant from each other between one and two inches; then pass from one to the other a strong charge of a large electrical battery: the plate of tin will be found pierced by two holes, with their burs in opposite directions. That the experiment may succeed, the tin-foil should be thin, and the charge strong, otherwise only two impressions will be seen on the plate.

Preservation of Eggs.

It is proposed to preserve eggs by covering them with a coat of gum arabic, rather than of varnish, and then to imbed them in charcoal. The gum is readily removed by water, and the charcoal preserves the eggs from any great and sudden change of temperature in passing from one country or situation to another.

Luminous Phenomena produced by a Flower.

Mr. Johnson had in the month of July a fine plant, the Polyanthus Tuberosa, about five feet in height, in blossom in a room, which, he observed, emitted its effluvium most strongly after sunset. One sultry evening, after thunder, (it is believed the 16th July, on which day the thermometer stood at 81° in the shade,) when the atmosphere was evidently highly charged with the electric fluid, Mr. Johnson was surprised at seeing small sparks, or scintillations of a lurid flame-colour, darted, with apparently exces-

sive rapidity and momentum from two or three of the expanded flowers, which were beginning to fade, and, at the same time, the odour was so powerful as to be palling and unpleasant. He could not perceive any difference in the strength of the odour at different intervals, but, during the whole evening, its intensity seemed to be equable. He has subsequently noticed that the smell from the flower is most diffused in the light, but he has not again observed the singular electric phenomenon, though he has nightly and attentively looked for it. During the time of the appearance of the flashes, or sparks, he was anxious to ascertain whether their emission was attended by a crackling or snapping noise, as is the case when the electric spark is elicited from a charged jar; but, though he was most attentive, he was not conscious of hearing the least noise.

Artificial Flowers.

Are made by passing hydrogen gas through metallic tubes, bent into various forms, and having a number of small orifices bored in them at certain distances. These tubes are affixed to a main pipe, which enters the bag or bladder containing the gas; and the gas is forced through them by pressing the bladder. The gas then issues from the small orifices into the atmosphere, and is there inflamed by the application of a lighted candle. If the machine is made partly, or in whole, moveable, a considerable increase is made to the effect.

Air Balloons.

A very pretty apparatus, of recent invention, is now to be had of the philosophical instrument makers. It is a little balloon, in shape resembling a bladder, and is to be had of various sizes. It is

made of the maw of a Turkey, and is so extremely light, that, when filled with hydrogen gas, and left free to the atmosphere, it ascends.

Coloured Inks.

Red.—Boil an ounce of Brazil-wood (in fine chips) in half a pint of water, for a quarter of an hour; and add to the decoction 3 drachms of gum-arabic, and as much alum as it will dissolve.

Blue.—Diffuse Prussian blue, or indigo, through strong gum-water.

Yellow.—Dissolve gamboge in gum-water.

Scarlet.—Dissolve vermilion in gum-water.

Inks of other colours may be made from a strong decoction of the materials used in dying, mixed with a little alum and gum-arabic.

Indelible Inks, useful for writing Labels for Bottles containing Acids, &c.

1. Take oil of lavender, 200 grains; gum copal, in powder, 25 grains; and lamp-black, 3 grains. Dissolve the copal in the oil of lavender, in a small flask or phial, by the aid of a gentle heat; and then mix the lamp-black with the solution, by trituration in a Wedgewood's-ware mortar. After a repose of some hours, the ink, before use, requires to be shaken, or stirred with an iron wire. If it be found too thick, it may be diluted with a little oil of lavender, or of turpentine.

2. A solution may be made, in like manner, of 120 grains of oil of lavender; 17 grains of copal, and 60 grains of vermilion.

3. Boil one ounce of finely rasped Brazil-wood, and half an ounce of alum, in twelve ounces of water, till the liquid is reduced to eight ounces; then decant the clear part, and add to it an ounce of calcined manganese mixed with half an ounce of gum-arabic.

Methods of polishing Shells.

The art of polishing shells has but lately reached its present state of perfection; and as the admiration of sea shells has become so general, it may be desirable to give some instructions in the means of adding to their natural beauty.

A shell which has a smooth surface, and a natural dull polish, need only be rubbed with a piece of chamois leather, on which is some tripoli, or fine rotten stone, and it will become of a bright and fine polish. A shell that is rough, foul, or crusty, or covered with a tartareous coat, must be left a whole day steeping in hot water; when it has imbibed a quantity of this, it is to be rubbed with rough emery on a stick, or with the blade of a knife, to get the coat off. After this, it is to be dipped in diluted aquafortis, spirit of salt, or any other acid; and after remaining in it a few moments, be again plunged in water. After this, it is to be well cleaned with soap on linen cloth; and when, by these several means, it is made perfectly clean, the polishing is to be finished with fine emery and a hair brush. If, when dry, the shell has not so good a polish as may be desired, it may be rubbed over with a solution of gum arabic, which must not be so thick as to give a sensible coat, only heightening the colours. If the shell has an epidermis, which prevents the polishing of it, it must be dipped several times in diluted aquafortis, and, after remaining in it a few minutes, be taken out, and plunged into common water. The progress the aquafortis makes is to be carefully observed each time it is taken out. The point of the shell, and any other tender parts, are to be covered with wax; also any worm holes; and a long piece of wax must be provided, and one end of it be made entirely to cover the mouth of the shell, the other will serve as a handle. When the repeated dippings into the aquafortis shew that the coat is sufficiently eaten away, then the shell is to be carefully wrought with fine emery and a brush, and, when highly po-

l, rubbed over with gum water or the white of g. When it is only a pellicle that hides the rs, the shell must be steeped in hot water, and, that, the skin worked off by degrees with an le.

ıen a shell is covered with a thick and fatty rmis, aquafortis will do no service, as it will ɔuch the skin: then a rough brush and coarse y are to be used; if that does not succeed, kin, or, as the workmen term it, *fish-skin* and *e-stone* are to be employed.

ese are the methods to be used with shells that re but a moderate quantity of the surface to ken off; but many require to be uncovered r: this is called entirely scaling a shell. This ıe by means of a horizontal wheel, impregnated rough emery; it is a work, however, of diffi-. Very often shells are cut down too far by it, wholly spoiled; to avoid this, a coarse vein often be left standing, and taken down after-s with the file, when the cutting down at the l would have spoiled the adjacent parts.

ter the shell is thus cut down to a proper de-it is to be polished with fine emery, tripoli, or n stone.

hen a shell is full of tubercles or protuberances, then impossible to use the wheel, and industry ıatience are the only means of effecting a po-

A camel's hair pencil must be dipped in aqua-ı, and with this the intermediate parts of the must be wetted, leaving the protuberances this is to be often repeated, and after a few ents the shell is always to be plunged into r, to stop the corrosion of the acid, which would wise cut too deep. When this has sufficiently sed the shell, it is to be polished with the finest y, or tripoli, by means of a small stick; or the ıon polishing stone used by goldsmiths may be

There will probably remain several places h could not be reached by any instrument, so the shell must necessarily be rubbed over with

gum-water or the white of an egg afterwards, to bring out the colours, and give a gloss; in some cases it is even necessary to give a coat of varnish.

Shells are subject to many imperfections; some of which are natural, and others accidental. Besides those arising from age and sickness in the fish, morbid cavities, or protuberances occur where they ought not. When the shell is valuable, these faults may be hid; the cavities may be filled with mastic or isinglass, dissolved in spirit of wine; these must be coloured to the tinge of the shell, or water-colours must finish them up to the resemblance of the rest; and then the whole shell being rubbed over with gum-water, or the white of an egg, scarce any eye can perceive the artifice; the same substance may also be used to repair the battered edge of a shell, if the pieces chipped off be not too large. When the excrescences of a shell are faulty, they are to be taken down with a fine file. If the lip of a shell be so battered that it will not admit of repairing by any cement, it must be filed down, or ground on the wheel till it becomes even.

Dr. Brewster's Microscopes.

The best method of constructing fluid microscopes, is to take Canada balsam, balsam of capivi or pure turpentine varnish, and let a drop of any of them fall upon a thin piece of parallel glass. The drop will form a plano-convex lens, and its focal length may be regulated by the quantity of fluid which is used. If the lens is uppermost, the gravity of the fluid will make it more flat, and diminish its focal length: this, however, may be avoided, and the contrary effect produced, by inverting the piece of glass. If these lenses are preserved from dust they will be as durable as those which are made of glass; and when thick Canada balsam is used, the lenses will soon be indurated into a hard gummy substance, and resist any change of figure from the *gravitation* of their parts.

On the Amalgam of Mercury and Silver, called Arbor Dianæ.

The same object, attained by modifying the common method; and this modification admits of our extracting, with facility, the metallic vegetation from the liquor, and preserving it, without any alteration, out of the vessel in which it has been formed.

The operation is very simple. In the nitric solutions of mercury and silver, both being well saturated and diluted with the quantity of water prescribed by Baume, is suspended a small knot of fine linen rag, doubled up, and containing five or six drachms of very pure mercury.

The metallic solutions soon penetrate to the mercury, which is enclosed in the rag, and we soon see some beautiful spiculæ formed and grouped around the rag, adhering to the nucleus of mercury, which serves as a kind of support for them.

These spiculæ progressively increase in size, and, in a short time, exceed an inch in length.

When we perceive that the metallic vegetation makes no more progress, the piece of rag with the spiculæ may be withdrawn from the liquor, and, by means of a silk thread fastened to the cork of the bottle, the whole may be suspended under a bell of glass. The crystals, which are tetrahedrons, may thus be kept as long as wanted.

Extemporaneous Printing Press.

Itinerant players often print their bills by laying the damped paper upon the form of letter previously inked, and give the pressure by a wooden roller, clothed with woollen cloth. Mr. Nicholson says, the form of letter must be disposed in a kind of frame, having its upper surface about one-thirtieth of an inch lower than the inked face, in order that the roller, being supported by the frame, may not be obliged to rise with much obliquity upon

the first letters; and that it may pass off at the other end with equal ease. This contrivance prevents the injury of the impression at the beginning and end of the rolling. The roller must be passed in the direction of the lines, or across the page, to prevent the bagging between line and line.

New Optical Machine, called the Phantasmascope.

In this apparatus, a concave mirror, fifteen inches in diameter, is placed at the extremity of a box about three feet long. The other end of this box has at its upper part a circular hole, about half the diameter of the mirror, through which the image is reflected outwards; and from its lower half a sort of drawer, whose end next the mirror is taken off, moves forwards and backwards as required; at the farther extremity of this drawer a sliding piece is laid, that may be moved lengthwise in it by a strong wire passing through the front of the drawer. This sliding piece has an upright partition attached to it, that traverses the drawer, in which is a circular aperture about three inches in diameter, over which a painting of the image desired to be seen, done on glass, or transparent paper, is placed; behind this partition, two short candles are fixed, whose light is partly reflected by a screen placed a little way farther back, which prevents the image of the inside of the drawer from being thrown on the mirror. On the top of the drawer a tin cover is fitted, to conceal the light; and a lid rises upwards from hinges in front of the top of the box, which both conceals the mirror, and gives passage to the smoke of the candles. The image, by this apparatus, appears in the air about three or four feet before the front of the box; and, by drawing the slide forward by the wire, seems to retire to a distance; and is made to advance again, by pushing the slide towards the mirror.

The effect of this method of throwing forward an

image into the air, differs from that which is used in the exhibition of the phantasmagoria, by its producing the phantom in a room, well illuminated, the light of which rather increases the perfection of of its appearance, while the other can only be shown to advantage in a dark apartment. The phantom appears considerably more beautiful than the image drawn on the glass; in painting which, care must be taken that all the parts of the glass surrounding the image be rendered perfectly opaque.

Representations of the moon and the planets have a very fine effect in the phantasmascope; the images for them are made by punching holes through thick paper, stained very black, and pasting it over rough-ground glass.

A pleasing appearance is also caused by introducing a small painting or coloured print, instead of the painting on glass, and placing the candles on the other side, between it and the mirror.

Phantasmagoric Chronometer, or Nocturnal Dial.

The exterior part of this apparatus consists of a vase, or ornamented case of any suitable materials, so constructed as to allow a free communication with the air, yet to prevent the rays of light from being visible, and having on one side a watch with two dials, and on the other a glass, or the combination of glasses, fixed in a sliding tube. The diameter of this glass is an inch and three quarters, and the pins two inches and three quarters; its use is to represent the nocturnal dial against the wall. A lamp is placed in the bottom of the vase, in such a manner as to be capable of being either taken out, or of having its position altered with respect to the magnifier of the dial. The exterior dial plate of the watch fixed in the side of the vase, is that of a common time-piece; but the inner one is made concave instead of convex, and, as well as the hands, consists of any kind of polished metal. Upon this

plate the numbers representing the hours are engraved in a reverse manner. It is a little inclined towards the light, and acts as a reflector to the light of the lamp, which renders it visible against the wall. This reflector or dial is supported by an arm fixed upon one of the plates of the watch. A steel centre is fixed upon the cock, and carries two cylinders, to which the hands, and the minute and hour wheels are attached: these wheels are double, namely, one on each side of the body of the watch, and made to act in unison with each other by a wheel and pinion.

The mysterious circulator, which the patentee states may be applied instead of the watch work above described, or may be used as a separate time-piece, or as an orrery, consists of the work of an horizontal or vertical watch, fixed in a box or globe representing the earth. A weight is attached to the hour-hand wheel, and the box with the watch and weight are fixed to one end of a lever, through which a steel axis passes. The other end of the lever carries a box, with a sufficient quantity of lead to counterbalance the watch in every position when in motion, and which is to be adjusted by trials, as different time-pieces require different weights. The whole of this apparatus rests upon two jewelled supporters, or friction rollers, screwed upon a stand, upon which is also fastened the support for the rim, which serves as a dial, upon which the hours and minutes are described. This rim may be divided into twelve or twenty-four parts, according to the construction of the time-piece: the hours and minutes are shown by one hand only, or, instead of which, a nonius may be applied to subdivide the minutes.

When this apparatus is to be used as a nocturnal dial, the reflector above described is fixed to the steel centre, and confined within the ornamental case that contains the lamp and magnifier; the hand showing the hours is likewise fixed within the case. Mr. Schmidt has also invented an apparatus, to be

fixed to the back of the box containing the watch-work, for representing the increase and decrease, as well as the regular revolution, of the moon round the earth. This motion is effected by a small weight being fixed to the axis of a pinion with six teeth, acting into a wheel with thirty teeth. The axis of this last carries another pinion, the teeth of which act upon a second wheel of thirty teeth, upon the axis of which the bent arm that supports the moon is fixed. This apparatus, turning round with the box or globe to which it is attached, causes the wheel which supports the moon to move one tooth every day.

Magical Music.

In a large case, such as is used for dials and spring clocks, the front of which, or, at least, the lower part of it, must be of glass, covered on the inside with gauze, let there be placed a barrel-organ, which, when wound up, is prevented from playing by a catch that takes a toothed wheel at the end of the barrel. To one end of this catch there must be joined a wire, at the end of which there is a flat circle of cork, of the same dimensions with the inside of a glass tube, in which it is to rise and fall. This tube must communicate with a reservoir that goes across the front part of the bottom of the case, which is to be filled with spirits, such as is used in thermometers, but not coloured, that it may be the better concealed by the gauze.

This case being placed in the sun, the spirits will be magnified by the heat, and, rising in the tube, will lift up the catch or trigger, and set the organ in play, which it will continue to do as long as it is kept in the sun; for the spirits cannot run out of the tube, that part of the catch to which the circle is fixed being prevented from rising beyond a certain point, by a check placed over it.

When the machine is placed against the side of a

room on which the sun shines strong, it may constantly remain in the same place, if you enclose it in a second case, made of thick wood, and placed at a little distance from the other. When you want it to perform, it will only be necessary to throw open the door of the outer case, and expose it to the sun.

But if the machine be moveable, it will perform in all seasons, by being placed before a fire; and in the winter it will more readily stop when removed into the cold.

Quantity of Air in Apples.

Dr. Hales found by experiment, that the air in apples is so much condensed, that if it were let out into the common air, it would fill a space 48 times as great as the bulk of the apples themselves; so that its pressure outwards was equal to 11,776 lbs.; and, in a cubic inch of oak, to 19,860 lbs. against its sides. So that, if the air was let loose at once in these substances, they would tear every thing to pieces about them with a force superior to that of gunpowder. Hence, in eating apples, it is well that they part with the air by degrees, as they are chewed, and foment in the stomach, otherwise an apple would be immediate death to him who eats it.

An apparent Impossibility.

A glass shall be quite filled with rain-water, yet substances shall be added and it shall not run over. Dissolve a portion of salt in the water; after which it will receive a certain quantity of sugar, and after that a certain quantity of alum, and perhaps other dissoluble bodies, and not increase its first dimensions; which proves that fluids have vacuities, or are not perfectly dense.

How light Wood may be made to lie at the bottom of Water.

Let two pieces of wood be planed quite flat, so as no water may get between them when they are put together: let one of the pieces be cemented to the bottom of a vessel, and the other piece be laid flat and close upon it, and held down to it by a stick, whilst water is poured into the vessel; then remove the stick, and the upper piece of wood will not arise from the lower one; for, as the upper one is pressed down, both by its own weight, and the weight of all the water over it, whilst the contrary pressure of the water is kept off by the wood under it, it will lie as still as a stone would do in its place. But if it be raised ever so little at any edge, some water will then get under it, which, being acted upon by the water above, will immediately press it upwards; and, as it is lighter than its bulk of water, it will rise, and float upon the surface of the water.

Improved Method of embossing Wood.

Raised figures on wood, such as are usually employed in picture frames, and other articles of ornamental cabinet work, are usually produced by means of carving, or by casting the pattern in plaster of Paris or other composition, and cementing or otherwise fixing it on the surface of the wood. The former mode is expensive, the latter is inapplicable on many occasions. This invention may be used either by itself or in aid of carving, and depends on the fact, that if a depression be made by a blunt instrument on the surface of the wood, such depressed part will rise again to its original level by subsequent immersion in water.

The wood to be ornamented having been first worked out to its proposed shape, is in a state to receive the drawing of the pattern. This being put on, a blunt steel tool is to be applied successively to

all those parts of the pattern intended to be in relief, and at the same time is to be driven very cautiously, without breaking the grain of the wood, till the depth of the depression is equal to the intended prominence of the figures. The ground is then to be reduced, by planing or filing, to the level of the depressed part: after which, the piece of wood being placed in water, either hot or cold, the part previously depressed will rise to its former height, and will then form an embossed pattern, which may be finished by the usual operations of carving.

Plaster of Paris, for Moulds, Casts, &c.

Put some powdered, calcined sulphate of lime into a basin, and pour over it as much water as will make it into a thin dough: mould this quickly into any shape. Almost before the moulding is complete, the whole mass will be so hardened, that it will require a heavy blow of a hammer to break it, or reduce it again to powder.

In preparing casts, moulds, &c., the plaster of Paris always gives out heat when it begins to set, or harden. This may be perceived by laying the hand on it at the time, when it will feel warm. Modellers say, that, when taking casts of any part of the human body, this is the instant when the plaster should be removed; as, whenever the cast becomes hardened, the *contraction*, or *condensation of bulk* is so great, as to cause most acute pain in the part under the operation.

Improvement in using Magnifying Glasses.

Many persons find it necessary, occasionally, to make use of a magnifying glass; in the use of which it is desirable to find, without loss of much time or distress to the eye, the proper focal distance. And it often so appears, that a partial use of the hand, required to support the lens, is wanted for other purposes.

In the first place, take a common pocket-lens, and drill a hole through the centre of each side of the horn or tortoiseshell case, almost the tenth of an inch in diameter: into which insert a slender spindle, of wood, about the size of a small quill, cut to a proper length, to suit the focus of the glass, and also a little tapering at the end. This very simple mode of mounting the glass, adjusts the focus at once at the object; allows a partial use of the hand that supports it, for other purposes, and leaves the hand at full liberty, for any operations that may be required.

If the free use of both hands is required, this also is provided for, by the small and cheap addition of a pedestal, consisting of a piece of wood of about two inches square, and half an inch thick; with a hole made through its centre, to receive the lower end of the said spindle of wood, which also must be made tapering.

Method of fixing Crayon Colours.

Crayon colours are easily defaced and spoiled; and an easy and certain method of fixing them without injury has long been a desideratum. A method has been tried by Mr. J. Smithson, which we shall give in his own words. "On thinking on the subject, the first idea which presented itself to me, was that of gum-water applied to the back of the picture; but as it was drawn on sized blue paper, pasted on canvas, there seemed little prospect of this fluid penetrating. But an oil would do so, and a drying one would accomplish my object. I applied drying oil, diluted with spirit of turpentine: after a day or two, when this was grown dry, I spread a coat of the mixture over the front of the picture, and my crayon drawing became an oil painting." Where this can be done without destroying the hue of the colours, this process will, no doubt, effect the object; and the use of those colours only which would bear the action of oil without change, would be a necessary precaution in works to be submitted to the process.

The Pantochronometer.

The Pantochronometer is one of those clever little philosophical instruments, which may be said to have *multum in parvo*, and the invention of which does credit to the ingenuity of modern science. It has been produced by Mr. Charles Essex, and it is at once a curious and useful thing. In a box, about the size of a small snuff-box, are combined the machinery of a compass, sun-dial, and universal time-dial; and a compass card, a gnomon, and an indexed border, are included in this apparatus. It is a desirable power, to be able to pull this "dial from your poke," and ascertain at once what o'clock it is, the situation of the spot where you are, and the way you ought to go.

Optical Experiment.

If a box be formed with a small aperture at one of its sides, and three candles be made to revolve on a piece of wood in the centre, the light opposite the axis will be visible on a semi-transparent screen, placed to receive its image. The other two candles will also have their flames depicted on the screen, at similar distances on each side. This experiment serves to shew the exceeding minuteness of the rays which emanate from the candles; for, if they were not exceedingly small, they would not pass each other without destroying the perfection of the image.

This experiment may be made very amusing by placing a piece of glass, with a ship or any other object painted on it, in the aperture; and when the candles are parallel to the screen, three images may be seen; but, on making them revolve through a quarter of a circle, only one image will be visible on the screen. By increasing the number of candles, the ships will be encreased in an equal ratio, and a single ship, by turning the row of candles, will be converted into an entire fleet.

Optical Illusion.

Suspend a ring freely to a string, on a level with the eye, but in such a manner that you cannot see the hole of the ring. Take a stick about a yard long, and fasten another smaller stick crosswise to one end of it. Then shut one eye and try to thread the ring with the small stick, and you will scarcely ever succeed; but use both eyes, and you will do it on the first attempt.

Another.

There is no person, probably, who, standing at one of the extremities of a long avenue, has not observed that the two rows of trees of which it is formed, appear to converge towards each other, so as even to touch, if the avenue be of sufficient length. In this case, the intervals between the corresponding trees on each side subtend visual angles, that regularly diminish, till at last they are insensible at a great distance. It follows in this, that in the small picture on the bottom of the eye, the images of the trees are situated on two lines that are inclined towards each other, and tend towards a common point. Now, if we suppose that the two optic axes direct themselves successively towards the different trees, as they increase in distance, the variation of these angles, and at the same time that of the impression of the distance, will continually become less perceptible; and, by a necessary consequence, the impression of the magnitude, which depends on the interval between the corresponding trees, will be so predominant, that it will nearly determine, of itself, the type of the sensation, so that two lines exactly parallel will present themselves to us under the aspect of two converging lines. It is owing to a similar cause that, when we are at the entrance of a long gallery, the ceiling appears to slope downwards a little, and the floor to rise.

Singular Illusion with the Fingers.

A very singular illusion may be produced, that has its origin in the touch.

If we pass the middle finger over the fore finger, so as to make this last turn towards the thumb, and we then place a small globular body under the tips of these fingers, and press it, that it may move exactly in contact with them, we shall imagine we feel two globes. In this case, the finger that is placed out of its natural position exerts an action, which, no longer in accord with the other finger, gives rise to a sensation that seems to refer to a new object.

Oriental Jewellery.

The Singalese work, in gold and silver, with considerable dexterity, ease, and taste; and, with means that appear very inadequate, execute articles of jewellery that would be certainly admired in this country, and not very easily imitated.

The best artists require only the following apparatus and tools:—a low earthen pot, full of chaff or saw-dust, on which to make a little charcoal fire; a small bamboo blow-pipe, about six inches long, with which he excites the fire; a short earthen tube, or nozzle, the extremity of which is placed at the bottom of the fire, and through which the artist directs the blast of the blow-pipe; two or three small crucibles, made of the fine clay of ant-hills, a pair of tongs, an anvil, two or three small hammers, a file, and, to conclude the list, a few small bars of iron and brass, about two inches long, differently pointed, for different kinds of work. It is astonishing what an intense little fire, more than sufficiently strong to melt silver and gold, can be kindled, in a few minutes, in the way described. Such a simple portable forge deserves to be better known. It is, *perhaps*, even deserving the attention of the scien-

tific experimenter, and may be useful to him when he wishes to excite a small fire, larger than can be produced by the common blow-pipe, and he has not a forge at command. The success of this little forge, it may be necessary to state, depends a good deal on the bed of the fire being composed of combustible materials, and a very bad conductor of heat.

The smiths of Ceylon use a composition similar to a hone, for sharpening knives and cutting-instruments, that is worth noticing. It is made of the capivi resin, and of corundum. The corundum, in in a state of impalpable powder, is mixed with the resin, rendered liquid by heat, and well incorporated. The mixture is poured into a wooden mould, and its surface levelled and smoothed while it is hot; for, when cold, it is extremely hard. It is much valued by the natives, and preferred by them to the best of our hones.

Preservation of Anatomical Preparations.

Dr. Godman objects to the substances usually recommended for the preservation of anatomical preparations, such as saltpetre, common salt, corrosive sublimate, and pyroligneous acid, in consequence of their action upon the edges of the knives, the two best, as preservers of the substance, being the worst as destroyers of the instruments. A better agent than any of the above, and one free from this great inconvenience, is common whiskey. Fix a pipe into a large artery, and inject the whiskey until no more can be thrown in. It does not flow out by the bowels or mouth, as the solution of common salt, which may be attributed to the action of the spirit contracting the delicate extremities of the capillary vessels. In this way, the whole of the muscular and cellular system is acted on; and if the skin be then sponged with impure pyroligneous acid, the body may then be kept for a great length of time, even in warm weather.

To take a Cast in Metal from any small Animal Insect or Vegetable.

Prepare a square box, sufficiently large to contain the subject, in which it must be suspended by a string, and the legs, wings, &c. of the animal, or the tendrils, leaves, &c. of the vegetable, must be separated, and adjusted, in their natural position, by a pair of small pincers. Mix some plaster of Paris with talc, tempered to a proper consistence with water, and oil the sides of the box. Put a strait piece of stick into the principal part of the body, and pieces of wire to the extremities of the other parts, that they may form, when drawn out after the clay is set and firm, proper channels for pouring in the metal, and vents for the air, which otherwise would burst the mould. When the plaster is set, withdraw the stick and wires, and remove the frame in which the mould was cast; and put the mould first into a moderate heat, which is to be encreased till the mould be red hot, when the subject in it will be burnt to a coal, and may be totally calcined to ashes, and blown out at the passages for pouring in the metal. The mould must then be suffered to cool gently, and will be hollow, the destruction of the substance included in it having produced a corresponding hollow. Be careful to expel with the bellows all the ashes, or, where it may be possible to fill the hollow with quicksilver, it will be found a very effectual method of clearing the cavity, as all impurities will be poured out with it.

The mould being thus prepared, it must be heated very hot, if the cast is to be made of copper or brass: a less degree will serve for lead or tin. The metal being poured into the mould, must be gently struck, and then suffered to rest till it is cold; then take it carefully, without force, from the cast; if any part adhere strongly, it must be removed by soaking it in water, that none of the delicate parts of the cast be broken or bent.

Red Chalk Crayons.

The red chalk crayon and its uses are too well known in daily life, to require any thing to be said of them. The preparation of those red crayons which are best adapted for drawing, however, is less known. The following is the manner in which it is performed:—

A quantity of hematite is ground in a porphyry mortar, with filtered water, until it be extremely divided, so as to form an impalpable powder. This powder is again diffused in a quantity sufficient to allow the finer parts of the mixture to be passed through a fine sieve, placed above a large vessel filled with water. The liquid holding the hematite in suspension is then agitated, and, after this, allowed to rest four-and-twenty hours. At the end of this time, there is formed at the bottom of the vessel a deposit of hematite, in the form of a very fine powder, and the water is cautiously decanted from it.

To form crayons of this impalpable powder, a uniting medium is necessary. This is afforded either by gum arabic or isinglass, of which the proportions vary, according to the use to which the crayon is destined; less of it being required for soft crayons, which, consequently, yield their colour more readily; and more for the hard ones, which preserve their points longer. The following are the proportions deduced from experiments, to be employed in the fine kinds of crayons.

1. For the soft crayons, which leave a broad trace, 18 grains of dry gum arabic to one ounce of the prepared hematite powder.

2. For harder crayons, 21 grains of gum, to one ounce of the hematite powder.

3. For still harder crayons, and which make small and delicate marks, 22 grains of gum to one ounce of hematite.

4. For the hardest of this kind, 27 grains of gum to one ounce of hematite.

5. For crayons which leave shining traces, 36

grains of isinglass to one ounce of the prepared hematite powder.

The gum or isinglass is to be dissolved separately in a sufficient quantity of water, and their solutions passed through a linen cloth: the hematite powder is then added. The liquid is brought near to a gentle fire, until the mass is somewhat thickened by the evaporation of the water, when it is to be removed from the fire. The mixture is then to be carefully ground on a porphyry slab, to render it as intimate as possible, and is ready to be formed into crayons. To effect this, the mass, when it has become of a proper consistence, is forced through a cylinder: the sticks thus formed are dried, and divided into crayons of two inches long. They are then sharpened at their points, and the hard crust which had formed upon them, while drying, is removed.

To write on Paper with Letters of Gold.

Put some gum arabic into common writing ink, and write with it in the usual way. When the writing is dry, breathe upon it; the warmth and moisture softens the gum, and will cause the gold leaf to adhere to it, which may be laid on in the usual way, and the superfluous part brushed off: or, instead of this, any japanners' size may be used.

To lay Paper Prints on the Inside of Glass Globes.

First, cut away all the white part of the impression, so that nothing appear but the print; then brush over the face side of it with strong gum water, or size; then put it into the globe, and with a long small stick, on which a camel's-hair pencil is fixed, stick it even on, and arrange what number of prints you please in the globe; let them dry about twelve hours, then pour some prepared plaster of Paris, *either* white, or tinged with any colour you please,

and turn the globe easily about, so that every part may be covered; pour out the superfluous plaster, and it is finished.

New Scarlet Colour.

Mr. Badams has recently described a process for obtaining scarlet chromate of lead; and highly recommends its use as a colour, either in painting or calico-printing. He prepares the scarlet chromate by boiling yellow chromate of lead with potash; and has made several experiments upon the properties of the scarlet colour thus obtained. It appears, that it may be made what is termed a fast colour in calico-printing, and that it is a durable and beautiful colour when used with oil, possessing considerable body. It is not degraded in its hue by admixture with white lead, as vermilion is; and it also mixes with other colours. As a water-colour, it has not been sufficiently tried to render it certain that it will not blacken; but several slips of card and thin paper, painted with it, and hung up in situations likely to affect colour, have not, in some months, perceptibly diminished in brightness. Mr. Badams very justly remarks, that, should it succeed, no tint would be a more desirable accession to the pallet than a bright and permanent scarlet, or scarlet orange.

Radiation of Heat.

The radiant matter, emitted by terrestrial bodies, at high temperatures, agrees in many of its properties with that constituting the solar rays; but in others it presents apparent peculiarities: the investigation of this subject constitutes a beautiful department of philosophic inquiry.

The effect we perceive in approaching a fire, chiefly results from radiation, and is little connected with the immediate conducting power of the air; and if a

concave *metallic* mirror be held opposite the fire, a heating and luminous focus will be obtained. The affections of terrestrial radiant matter are best demonstrated by employing two concave mirrors of planished tin or plated copper, placed at the distance of about ten feet asunder. Under these circumstances, when a thermometer is in the focus of one of the mirrors, it will be found sensible to the effects of a heated body placed in the focus of the opposed mirror; and that effect is produced by reflection, and not by mere direct radiation, is proved, either by drawing the thermometer out of the focus towards the opposed mirror, or by placing a screen between the thermometer and its mirror, when diminution of temperature is in either case indicated. In these experiments, the differential thermometer is most advantageously employed, and the mirrors may be placed opposite each other on the ground, or vertically suspended as at *Fig.* 28, where *a a* represent the mirrors, *b* a pan of hot charcoal, and *c* an air thermometer.

The Cylindric Oracle.

Provide a hollow cylinder of about six inches high and three wide, a A, B, *Fig.* 29, its cover C D, must be made to fix on. On one side of the cylinder let there be a groove, nearly of the same length with that side; in which place a small steel bar that is strongly impregnated, and with the north pole the bottom of the cylinder. On the upper side of the cover describe a circle; and divide it into ten equal parts, in which are to be wrote the numbers from 1 to 10. Place a pivot at the centre of this circle, and have ready a magnetic needle. Then provide a bag in which are several divisions; in each of which put a number of papers, on which amusing questions are written. In the cylinder put several different answers to these questions, and seal them up, like *billets doux*. On each of these answers write one of the numbers of the circle at the top of the box.

You are supposed to know the number of the answers to each question. You then offer one of the divisions of the bag, observing which division it is, to any person, and desire him to draw one of the papers. Next put the cover on the cylinder, with that number which is written on the answer directly over the bar. You then desire the person who drew the question to observe the number at which the needle stands, and to search in the box for a paper with the same number, which he will find to contain the answer.

Repeat the experiment by offering another division of the bag to another person; and placing the number that corresponds to the answer over the magnetic bar, proceed as before.

It is easy to imagine several answers to the same question.

Ideal Spectrum.

I was surprised, and agreeably amused, (says Dr. Darwin,) with the following experiment. I covered a paper about four inches square with yellow, and with a pen filled with a blue colour wrote upon the middle of it the word BANKS in capitals, and sitting with my back to the sun, fixed my eyes for a minute exactly on the centre of the letter N in the middle of the word; after closing my eyes, and shading them somewhat with my hand, the word was distinctly seen in the spectrum in yellow letters on a blue field; and then, on opening my eyes on a yellowish wall at twenty feet distance, the magnified name of BANKS appeared written on the wall in golden characters.

Foils for Crystals, Pebbles, or Paste, to give the lustre and play of Diamonds.

The manner of preparing foils, so as to give colourless stones the greatest degree of play and lustre, is by raising so high a polish or smoothness

on the surface, as to give them the effect of a mirror, which can only be done, in a perfect manner, by the use of quicksilver, applied in the same general way as in the case of looking-glass. The method by which it may be best performed is as follows.

Take leaves of tin, prepared in the same manner as for silvering looking-glasses, and cut them into small pieces of such size as to cover the surface of the sockets of the stones that are to be set. Lay three of these then one upon another, and, having moistened the inside of the socket with thin gum-water, and suffered it to become again so dry that only a slight stickiness remains, put the three pieces of leaves lying on each other into it, and adapt them to the surface in as even a manner as possible. When this is done, heat the socket, and fill it with warm quicksilver, which must be suffered to continue in it three or four minutes, and then gently poured out. The stone must then be thrust into the socket, and closed with it, care having been taken to give such room for it that it may enter without stripping off the tin and quicksilver from any part of the surface. The work should be well closed round the stone, to prevent the tin and quicksilver contained in the socket from being shaken out by any violence.

The lustre of stones set in this manner will continue longer than when they are set in the common way, as, the cavity round them being filled, there will be no passage found for moisture, which is so injurious to the wear of stones treated in any other way.

This kind of foil likewise gives some lustre to glass, or other transparent matter, which has little, of itself; but to stones or pastes, that have some share of play, it gives a most beautiful brilliant.

To colour Foils.

Two methods have been invented for colouring foils; the one by tinging the surface of the copper of the colour required by means of smoke, the other by staining or painting it with some pigment or other colouring substance.

The colours used for painting foils may be tempered either with oil, water rendered duly viscid by gum-arabic, size, or varnish. Where deep colours are wanted, oil is most proper, because some pigments become wholly transparent in it, as lake, or Prussian blue; the yellow and green may be better laid on in varnish, as these colours may be had in perfection from a tinge wholly dissolved in spirit of wine, in the same manner as in the case of lacquers; and the most beautiful green is to be produced by distilled verdigris, which is apt to lose its colour and turn black with oil. In common cases, however, any of the colours may be, with the least trouble, laid on with isinglass size, in the same manner as the glazing colours used in miniature painting.

Ruby Colours.

For red, where the ruby is to be imitated, a little lake used in isinglass size, carmine, or shellac varnish, is to be employed, if the glass or paste be of a full crimson, verging towards the purple; but if the glass incline to the scarlet or orange, very bright lake (that is, not purple) may be used alone in oil.

Garnet Red.

For the garnet red, dragon's blood dissolved in seedlac varnish may be used; and for the vinegar garnet, the orange-lake tempered with shellac varnish, will be found excellent.

Amethyst.

For the amethyst, lake, with a little Prussian blue, used with oil, and very thinly spread on the foil, will completely answer the end.

Blue.

For blue, where a deep colour, or the effect of the sapphire is wanted, Prussian blue, that is not too deep, should be used in oil, and it should be spread more or less thinly on the foil, according to the lightness or deepness of the colour required.

Eagle Marine.

For the eagle marine, common verdigris, with a little Prussian blue, tempered in shellac varnish.

Yellow.

Where a full yellow is desired, the foil may be coloured with a yellow lacquer, laid on as for other purposes; and for the slighter colour of topazes, the burnish and foil itself will be sufficiently strong, without any addition.

Green.

For green, where a deep hue is required, the crystals of verdigris, tempered in shellac varnish, should be used; but where the emerald is to be imitated, a little yellow lacquer should be added, to bring the colour to a true green, and less verging to the blue.

Other Colours.

The stones of more diluted colour, such as the amethyst, topaz, vinegar-garnet, and eagle-marine, may be very cheaply imitated by transparent white glass or paste, even without foils. This is to be done, by tempering the colours above enumerated with turpentine and mastic, and painting the socket in which the counterfeit stone is to be set with the mixture, the socket and stone itself being previously heated. In this case, however, the stone should be immediately set, and the socket closed upon it before the mixture cools and grows hard. The orange-lake above-mentioned was invented for this purpose, in which it has a beautiful effect, and was used with great success by a considerable manufacturer. The colour it produces is that of the vinegar-garnet, which it affords with great brightness. The colours before directed to be used in oil should be extremely well ground in oil of turpentine, and tempered with old nut or poppy-oil, or, if time can be given for their drying, with strong fat oil, diluted with spirit of turpentine; which will gain a fine polish of itself.

The colours used in varnish should be likewise thoroughly well ground and mixed; and in the case of the dragon's blood in the seedlac varnish and the lacquer, the foils should be warmed before they are laid out. All the mixtures should be laid on the *foils* with a broad soft brush, which must be passed

from one end to the other, and no part should be crossed, or twice gone over, or, at least, not till the first coat can be dry; when, if the colour do not lie strong enough, a second coat may be given.

To make Varnish for coloured Drawings.

Take one ounce of Canada balsam, and two ounces of spirit of turpentine, and mix them together.

Before this composition is applied, the drawing or print should be sized with a solution of isinglass in water; and when dry, apply the varnish with a camel's hair brush.

To varnish Glass.

Pulverize a quantity of gum adragant, and let it dissolve for twenty-four hours in the white of eggs well beat up; then rub it gently on the glass with a brush.

Mackintosh's Water-proof Cloth.

A most valuable process has lately been invented, by Mr. Charles Mackintosh, for rendering cloths, leather, and paper, impervious to water and air. It consists in joining the surfaces of two or more pieces of cloth, leather, or paper, by a flexible varnish, made of India-rubber dissolved in the naptha obtained in the distillation of coal. The cloth is stretched on a frame, and then covered by means of a brush with a coat of the elastic varnish; another piece of cloth is prepared in a similar manner, and as soon as the varnish has dried till it has a certain degree of adhesiveness, the varnished surfaces are joined together, and to render the union of the surfaces perfect, the cloth is passed through a roller press. It is afterwards dried in a warm room.

The cloth thus prepared is of various thicknesses,

from that of fine cloth to the substance of the strongest hide leather. Besides being useful for outer garments to keep off rain, it is likely to be extensively employed for various purposes in the arts and manufactures.

To take Impressions from recent Manuscripts by means of the fusible Metal.

In order to shew the application of it, paste a piece of white paper on the bottom of a china saucer, and allow it to dry: then write upon it with common writing ink, and sprinkle some finely powdered gum-arabic over the writing, which produces a slight relief. When it is well dried, and the adhering powder brushed off, the fusible metal is poured into the saucer, and is cooled rapidly to prevent crystallization. The metal then takes a cast of the writing; and when it is immersed in slightly warm water, and any adhering gum removed, impressions may be taken from it as from a copper-plate.

Range of Shot, Rockets, and Bombs.

The range of Congreve's rockets is 3,300 yards, or nearly two miles.

The large mortar in the park is said to have thrown a thirteen-inch bomb-shell, filled with lead, above three miles.

The mean vertical ascent of a great number of common rockets, discharged at Woolwich for the purpose of ascertaining the comparative strength of gunpowder, was 480 yards.

Ingenious Filter.

Mr. Donovan has invented an apparatus for fil-'g liquids without exposing them to the atmos-. This apparatus must be exceedingly useful

for filtering any liquid to which the carbonic acid, or the moisture of the atmosphere, would be injurious; and also for any thing of a volatile nature, as alcohol, ether, ammoniacal liquor, &c. The apparatus consists of an upper and a lower glass vessel; the upper one being formed as a funnel, but with a neck and stopper at the top of it. The lower vessel has two necks, into one of which the funnel is inserted, and the other neck is connected to the neck at the top of the funnel by a long bent tube of glass. In consequence of this arrangement, whatever drops from the funnel which contains the filter displaces an equal volume of air from the lower vessel, and the air ascends to the upper one by the bent tube.

Musical Flame.

Musical tones are produced by the combustion of hydrogen gas in tubes of different diameters.

Remarkable Wood.

Mr. Boyle describes the *lignum nephriticum* to be a whitish kind of wood, brought from Mexico, which the natives call *coatl* or *tlapasatli*, and which he found to communicate all kinds of colours. If, says he, an infusion of this wood be put into a glass globe, and exposed to a strong light, it will be as colourless as pure water; but if it be carried into a place a little shaded, it will be a most beautiful green; in a place still more shaded, it will incline to red; and a very shady place, or in an opaque vessel, it will be green again. He also distinctly noted the two very different colours which this remarkable tincture exhibits by transmitted and reflected light. If, says he, it be held directly between the light and the eye, it will appear tinged (excepting the very top of it, where a sky-coloured circle sometimes appears) almost of a golden colour, unless the infusion be too strong; in which case it will be dark

or reddish, and requires to be diluted with water. But if it be held from the light, so that the eye be between the light and the vessel, it will appear of a deep lovely blue colour; as will also the drops, if any lie on the outside of the glass.

The Flute Player of Vaucanson.

A particular account of the mechanism of this beautiful automaton has been published in the Memoirs of the French Academy.

The figure was about five feet six inches high, and was placed upon an elevated square pedestal. The air entered the body by three separate pipes, into which it was conveyed by nine pairs of bellows, which expanded and contracted in regular succession, by means of an axis of steel turned by the machine.

The three tubes, which conveyed the air from the bellows, after passing through the lower extremities of the figure, united at the chest; and ascending from thence to the mouth, passed through two artificial lips. Within the cavity of the mouth was a small moveable tongue, which by its motion at proper intervals, admitted or intercepted the air in its progress to the flute. The fingers, lips, and tongue, derived their specific movements from a steel cylinder turned by clock-work. The cylinder was divided into fifteen equal parts, which, by means of keys, pressing upon a like number of levers, caused the other extremities to ascend. Seven of these levers directed the fingers, having rods and chains fixed to their ascending extremities; which, being attached to the fingers, made them to ascend in proportion as the other extremity was pressed down by the motion of the cylinders, and *vice versa*. Three of the levers served to regulate the ingress of the air, being so contrived as to open and shut, by means of valves, the communication between the lips and reservoir, so that more or less strength

might be given, and a higher or lower note produced as occasion required.

The lips were directed by four similar levers; one of which opened them to give the air a freer passage; another contracted them; a third drew them backward, and the fourth pushed them forward. The remaining lever was employed in the direction of the tongue, which, by its motion, shut or opened the mouth of the flute. The varied and successive motions performed by this ingenious androides, were regulated by a contrivance no less simple and efficacious. The axis of the steel cylinder or barrel was terminated by an endless screw composed of twelve threads, above which was placed a small arm of copper, with a steel stud made to fill the threads of the worm, which, by its vertical motion, was continually pushed forward. Hence, if a lever was moved, by a peg placed on the cylinder, in any one revolution, it could not be moved by the same peg in the succeeding revolution, in consequence of the lateral motion communicated by the worm. By this means, the size of the barrel was considerably reduced; and the statue not only poured forth a varied selection of instrumental harmony, but exhibited all the evolutions of the most graceful performer.

To determine the magnifying Power of Glasses employed in Single Microscopes.

If the focus of a convex lens be at one inch, and the natural sight at eight inches, which is the common standard, an object may be seen through that lens at one inch distant from the eye, and will appear in its diameter eight times larger than to the naked eye. But as the object is magnified every way equally, in length as well as in breadth, we must square this diameter to know how much it in reality appears enlarged; we shall then find its superficies is magnified 64 times.

Another mode of conversing by means of a Silk String.

The letters of the string alphabet are distributed into seven classes, which are distinguished by knots; each class comprehends four letters, except the last, which comprehends but two. The first, or A class, is distinguished by a large round knot; the second, or E class, by a knot projecting from the line; the third, or I class, by a series of links; the fourth, or M class, by a simple noose; the fifth, or Q class, by a noose with a line drawn through it; the sixth, or U class, by a noose with a net-knot cast on it, and the seventh, or Y class, by a twisted noose. The first letter of each class is denoted by the simple characteristic of its respective class; the second by the characteristic, and a common knot close to it; the third, by the characteristic, and a common knot half an inch from it. Thus A is simply a large round knot; B is a large round knot, with a common knot close to it; C is a large round knot, with a common knot half an inch from it, and so on.

A person may easily acquire a knowledge of the string alphabet in an hour, and retain it for ever.

Distinction of Positive and Negative Electricity.

Positive and negative electricity may be readily distinguished by the taste, on making the electric current pass, by means of a point, on to the tongue. The taste of the positive electricity is acid, that of the negative electricity is more caustic, and, as it were, alkaline.

Electricity produced by Congelation of Water.

When the water is rapidly frozen in a Leyden jar, the outside coating not being insulated, the jar receives a feeble electrical charge, the inside being positive, the outside negative. If this ice be ra-

pidly thawed, an inverse result is obtained, the interior becomes negative, and the outside positive.

Rapid Transmission of Electricity.

Electricity is not expended by shocks, and its effects take place in no sensible time. A discharge through a circle of four miles was found to be quite instantaneous.

Enigmatic Metals.

Procure a proper mould, and form in it two balls of pure copper, and two balls of pure tin. Now put the copper balls into a crucible, and when in a state of fusion, put in the tin balls. When both have been melted and properly combined, recast the alloy, by pouring it into the mould. Instead of four balls, the operator will be able to form only three.

The quantity of metal is exactly the same as at first, but the alloy is capable of being more compact than the metals in a separate state.

Curious Alloy of Silver with Steel.

If steel and silver be kept in fusion together for a length of time, an alloy is obtained, which appears to be very perfect while the metals are in a fluid state; but on solidifying and cooling, globules of pure silver are expressed from the mass, and appear on the bottom of the button. If the alloy be forged into a bar, and then dissected by the action of dilute sulphuric acid, the silver appears, not in combination with the steel, but in threads throughout the mass, so that the whole has the appearance of a bundle of fibres of silver and steel, as if they had been united by welding. The appearance of these silver fibres is very beautiful.

Probability of Life.

For the sake of easy calculation, De Moire assumed 86 as the boundary of human life, from which having deducted the person's age, (if 30 or upwards) the remainder is the average time that a man may expect to live. Thus—

Boundary of human life.....	86 years.
Suppose an individual's age to be ..	40 „
	½) 46
Average expectation of life	23

The period of life at which man (under all circumstances) has the probability of the greatest number of years to come, is the age of 33. To this all the powers of medicine will probably never be able to add $\frac{1}{360}$th part, viz. one month, and thus to make a perceptible addition to the mean term of human life. Medicine operates principally for the temporary relief of individual suffering.

If the probability that one man, A, shall live a year be $\frac{6}{10}$, and the probability of the life of another man, B, for one year be $\frac{2}{10}$, the probability that both shall die within the year is $\frac{4}{10} \times \frac{2}{10} = \frac{8}{100}$.

The probability that one of the events shall happen and the other fail, is, as the probability of the happening of the one, multiplied by the probability of the failure of the other. So, in the above case, the probability that A shall live and B die is $\frac{6}{10} \times \frac{2}{10} = \frac{12}{100}$; and the probability that B shall live and A die is $\frac{8}{10} \times \frac{4}{10} = \frac{32}{100}$.

* *If Seven is the Main, and Six or Eight the Chance, what is the probability of its being determined in Two Throws?*

This is a common bet at hazard, when 7 either with 6 or 8 are concerned; but whoever bets an

equal sum, that it will be determined or off in two throws, is entitled to about $\frac{1}{28}$ part of his adversary's stake, or nearly £3. 11*s.* per cent. to cancel the agreement; for there being 6 chances for 7, and 5 chances for either 6 or 8, the probability of throwing one of them the first throw is $\frac{11}{36}$, and the contrary is $\frac{25}{36}$; the probability that neither will come up in two throws, is $\frac{25}{36} : \frac{25}{36} = \frac{625}{1296}$, and the difference, or $\frac{671}{1296}$, is the probability that one of them will come up in two throws, being $\frac{1}{1\frac{25}{671}}$, or nearly $\frac{1}{28}$ part of the adversary's stake advantage: but this is the sum that should be paid the adversary, so as to reduce the money and chances to equality; for the money ought to be deposited £103. 11*s.* to £96. 9*s.*, or £107. 7*s.* 2*d.* to £100., according to the chances; and, if equal sums only are bet, such is the ratio of profit on one side.

The Ratio of Adventure.

If A and B each deposit £100, and they agree to toss up for the sum, each of them having one chance, A's value in B's stake is half of £100, and B's value in A's stake is the same; therefore, the ratio of the values in exchange being 50 to 50, there is neither profit nor loss; but suppose A deposits £100, and B £200, here A's value is half of £200, or £100, and B's value only half of £100, or £50, the ratio of the values being two to one; and as A receives a value £100 for a value £50, he adventures in the ratio of 100 per cent. profit. If A bets B five guineas to two, that an ace is not thrown the first trial, with a single die, A's profit is in the ratio of 100 per cent., the same as in the above case; for, having five chances to B's one, *he ought* to bet five times B's stake, or ten guineas; if so, their values in each other's stake would be equal; but betting only five guineas, B's value in A's stake is one-sixth of five guineas, or 17*s.* 6*d.*, which, being exchanged for A's value *in B's saake*, or five-sixths of two guineas,

equal to 35*s.* the ratio of profit, or advantage, is 100 per cent.

Postage.

The following progressive amount of postage of letters for 120 years, is a curious document.

		£.
In 1644.	Edmund Prideux, Postmaster ..	5,000
1654.	Manley	10,000
1664.	Daniel O'Neil	21,000
1674.	Unknown	43,000
1685.	ditto	65,000
1688.	ditto	76,218
1697.	ditto	90,505
1710.	ditto	111,461
1715.	ditto	145,227
1744.	ditto	235,492
1764.	ditto	432,048

Barometer Tubes.

A tube, a quarter of an inch in diameter, is a good width for a barometer. If the tube be perfectly clean, pure mercury has always a convex surface: if soiled or stained, the mercury will become flat or concave.

The Weather Prognosticator, through all the Lunations of each Year, for ever.

This Table and the accompanying remarks are the result of many years actual observation; the whole being constructed on a due consideration of the attraction of the sun and moon in their several positions respecting the earth; and will, by simple inspection, shew the observer what kind of weather will most probably follow the entrance of the moon into any of her *quarters*, and that so near the truth as to be seldom or never known to fail.

Moon.	Time of Change.	In Summer.	In Winter.
If the new moon—the first quarter—the full moon, the last quarter happens	Between midnight and two in the morning	Fair	Hard frost, unless the wind be S. or W.
	—— 2 and 4 morning	Cold with frequent showers	Snow and stormy.
	—— 4 and 6 ,,	Rain	Rain.
	—— 6 and 8 ,,	Rain and wind	Stormy.
	—— 8 and 10 ,,	Changeable	Cold rain, if wind W., snow if E.
	—— 10 and 12 ,,	Frequent showers	Cold and high wind.
	At 12 o'clock at noon and at 2 p. m.	Very rainy	Snow and rain.
	Between 2 and 4 afternoon	Changeable	Fair and mild.
	—— 4 and 6 ,,	Fair	Fair.
		Fair, if wind N.W.	Fair and frosty, if wind N. or N.E.
	—— 6 and 8 ,,	Rainy, if S. or S.W.	Rain or snow, if S. or S.W.
	—— 8 and 10 ,,	Ditto	Ditto.
	—— 10 and midnight	Fair	Fair and frosty.

Observations.

1. The nearer the time of the moon's change, first quarter, full, and last quarter, is to midnight, the fairer will the weather be during the seven days following.

2. The space for this calculation occupies from ten at night till two next morning.

3. The nearer to mid-day or noon these phases of the moon happen, the more foul or wet the weather may be expected during the next seven days.

4. The space for this calculation occupies from ten in the forenoon to two in the afternoon. These observations refer principally to summer, though they affect spring and autumn nearly in the same ratio.

5. The moon's change, first quarter, full, and last quarter, happening during six of the afternoon hours, *i. e.* from four to ten, may be followed by fair weather: but this is mostly dependent on the wind, as it is noted in the table.

6. Though the weather, from a variety of irregular causes, is more uncertain in the latter part of autumn, the whole of winter, and the beginning of spring, yet, in the main, the above observations will apply to those periods also.

Description of an Udometer, a new Instrument, which shews the Quantity of Rain fallen.

This instrument is composed of a circular basin, made of tin plate or copper, the outer edge of which is surrounded by a double inclosure, forming a canal. An opening is made six lines above the bottom, so that the basin cannot become full of water, but all the rain that falls into it runs out through this opening, into a receiver placed beneath. Through the whole height of this vessel there is a vertical slip, covered by a stripe of glass, which closes it hermetically, and allows the height of the surface *of the* water in the vessel, and all its variations, to

be seen. A scale, divided into inches and parts, is marked at one side: and a tube, closed by a cork, serves for emptying the vessel when it is full of water. The basin communicates, by a closed canal above, with another and a smaller basin, surmounted by a cylindrical reservoir, which has likewise a longitudinal opening, closed by a piece of glass, in the same manner as in the larger basin. At the side a scale is marked, which is lengthened in the ratio of the difference of the diameters of this reservoir and of the large basin. This reservoir, which is filled with water before it is put in its place, being constructed like the reservoirs which supply oil to the wick of an argand lamp, replaces the water which evaporates from the large basin, by means of the canal of communication. The effect of this instrument is as follows:—When it rains, all the water that falls into the large basin passes into the receiver below, where the quantity of it may be afterwards measured. When the rain is over, and evaporation begins to take place, the water which evaporates from the large basin is immediately replaced by the water contained in the little reservoir, and the scale on the latter shews at once the quantity.

Colours considered in Bodies.

Bertholet, the celebrated French chemist, remarks, that the three primitive colours in the arts develope themselves in the bodies of the three *mineral*, *vegatable*, and *animal* kingdoms, by a greater or less absorption of oxygen, which combines with the different principles of those bodies.

In its natural state, iron is without colour. The first impression of fire, or the first degree of oxydation, developes a blue colour; a second degree of oxydation produces yellow: if the oxydation augments, the iron becomes red. The major part of *metals* present similar phenomena.

In *vegetables*, the blue is formed by fermentation,

that is to say, by a fixation of oxygen; and most of these colours are susceptible of passing to red by a greater quantity of oxygen. It is thus that turnsol is reddened by air, and by the action of acids.

The same colours are seen to develope themselves in *animals*, by the combination of oxygen. When meat putrefies, the first degree of oxydation decides the blue colour; the red colour soon succeeds it, as the oxygenation augments. This phenomenon is very perceptibly manifest in the preparation of cheeses, which are covered first with a blue mould, that afterwards becomes red.

Lastly, the flame of burning bodies exhibits the same phenomena. It is blue when the combustion of oxygen is slow, red when it is stronger, and white when the oxygenation is complete. It would seem that the maximum of oxydation determines the reflection of rays of every kind, in the same proportions as subsist in solar light.

An easy method of comparing the Time indicated by any number of Chronometers, with the given time at a certain Season.

Let a transit instrument, or even a sextant with an artificial horizon, be established in a conspicuous situation on shore, where a clock can always be regulated to true time: then provide a powerful argand's lamp, with a shutter, so as to be able to darken the lamp instantaneously. A few minutes before a certain hour in the evening, notice being previously given to the ships, let the lamp be lighted, and at the proper instant of time let it be darkened: this may be repeated several times, at short known intervals. Then the errors of every chronometer on board of all the ships from which the lamp can be seen are immediately found. After a certain number of days, let the same be repeated, when the daily *ship rates* will be given, since they are only *the* differences of those errors, divided by the num-

ber of days elapsed between the two acts of observations. No objection can be made from the chronometer being generally below deck, as one person might have his eye upon it, and another immediately above him on the upper deck might give a stamp with his foot the instant the lamp is darkened.

The Wheel Barometer in the form of a Syphon.

A small float of iron or glass rests on the exterior surface of the mercury, suspended by a slender thread, passed round a small wheel, or cylindrical axis, that carries the index. By this construction, the variation of the height of the mercurial column is reduced to half the ordinary measure, yet the circumference traversed by the needle is greatly augmented.

Artificial Cold.

The greatest artificial cold that has yet been produced, was effected by the mixture of diluted sulphuric acid with snow, which sunk Fahrenheit's thermometer to 91°, or 123° below the freezing point.

Neutralization of the Attraction of the Ship's Iron, usually called Deviation.

Place the centre of a small circular iron plate in the line of no attraction (of the ship's iron), and at a proper distance *behind* and *below* the pivot of the compass needle, (which must be ascertained and fixed before the ship leaves port), and the needle will not only remain active and vigorous in the polar regions, but will continue to point to the correct magnetic meridian, uninfluenced by the attraction of the ship's iron in every part of the world.

Spontaneous Combustion.

There are instances of spontaneous combustion of the human body by the rapid absorption of oxygen, so that the whole became silently reduced to ashes, independent of any external agent to which the commencement of the combustion could be attributed. These instances have always occurred to females addicted to spirituous liquors.

Safest Situation during a Thunder Storm.

The safest situation during a thunder-storm is the cellar; for when a person is below the surface of the earth, the lightning must strike it before it can reach him, and will of course, in all probability, be expended on it. Dr. Franklin advises persons apprehensive of lightning to sit in the middle of a room, not under a metal lustre, or any other conductor, and to lay their feet upon another chair. It will be safer still, he adds, to lay two or three beds or mattrasses in the middle of the room, and folding them double, to place the chairs upon them. A hammock suspended by silk cords would be an improvement upon this apparatus. Persons in fields should prefer the open parts to the vicinity of trees, &c. The distance of a thunder storm, and consequently the danger, is not difficult to be estimated. As light travels at the rate of 72,420 leagues in a second of time, its effects may be considered as instantaneous within any moderate distance. Sound, on the contrary, is transmitted only at the rate of 1,142 feet, or about 380 yards, in a second. By accurately observing therefore the time which intervenes between the flash and the noise of thunder which follows it, a very near calculation may be made of its distance, and I know no better means of removing apprehensions.

Beautiful Electrical Experiment.

Take some oxalate of lime, obtained by precipitation, well washed, and dried in a Wedgewood's basin at a temperature of 300°, until so dry as not to render a cold glass plate, placed over it, dim. Stir it with a platina spatula; in a few moments, by friction against the metal, it will become so strongly electrical, that it cannot be collected together, but will fly about the dish whenever it is moved, and over its sides into the sand-bath. It requires some little stirring before the particles of the powder are all of them sufficiently electrical to produce this effect.

Amusing Explosion.

There is a tree growing in America, which they call the Devil's tree; its fruit, in a state of maturity, is elastic, and when dried by the heat of the sun, noisily splits, and bursts forth its grains. To this sport of nature, the tree owes its name; for, at the moment of bursting, the effect of a piece of artillery is produced, the noise of which succeeds rapidly, and is heard tolerably far off. If its fruit be transplanted, before it is ripe, to a dry place, or exposed on a chimney-piece to a gentle heat, it will have the same effect, and produce the same phenomenon.

New mode of securing Anatomical Preparations.

Dr. Macartney, of the University of Dublin, has employed a thin plate of Indian rubber as a covering for preparation jars, in place of the former laborious and offensive one, by means of putrid-bladder, sheet-lead, &c. It is essential, that the Indian rubber should be painted or varnished; after which, not the slightest evaporation of the spirits takes place.

The material, by its elasticity, adapts itself to the variations in the volume of the contents of the jar from different temperatures, and this removes the principal cause of the escape of the spirits. It is probable, that leather coated with Indian rubber, and painted, would answer as well as the rubber itself, by which the expense would be greatly diminished.

Sir William Herschel's Telescope.

The speculum of Sir William Herschel's 45 feet telescope was 49½ inches in diameter, 3½ inches in thickness, and weighed when newly cast 2118 pounds. It magnified 6450 times, and was completed on the 27th August, 1789.

Light and Heat on the Planetary Bodies.

The following Table exhibits the relative intensities of light and heat at the different planets, and the apparent diameter of the sun seen from them.

Planets.	Intensities of Light and Heat.	Apparent Diameter of the Sun.
Mercury.....	6.25	80′
Venus.....	2.04	45.7
Earth	1	32
Mars	0.44375	21.33
Jupiter	0.036875	6.15
Saturn.....	0.01106	3.37
Georgian	0.00276	1.64

Description of Monochords.

Monochords are peculiar in having *one* string only, as the name imports.

The best contrived monochords are those of Earl Stanhope and Mr. Attwood. In the Stanhope monochord, the peculiarities are these:

1st. The wire is made of steel, which does not keep continually lengthening, like brass or iron.

2dly. The whole wire forms one straight horizontal line, so that the moveable bridge can be moved without altering the tension of the wire, which is not the case when the wire pulls downwards on the bridges.

3dly. The ends of the wire are not twisted round the two stout steel pins that keep it stretched; but each end of the wire is soft soldered in a long groove formed in a piece of steel, which goes over the corresponding pin.

4thly. One of these steel pins is strongly fastened by a brass slider, which is moved by means of a screw with very fine threads; this screw having a large micrometer head minutely divided on its edge, and a corresponding *nonius*, whence the tension of the wire may be very exactly adjusted.

5thly. A slider is fixed across the top of the moveable bridge, and is moved by means of another screw with very fine threads.

6thly. The slider is adjusted to the steel rod or scale, by means of mechanical contact against projecting pieces of steel, firmly fixed on that steel scale, at the respective distances specified in the monochord table.

7thly. Each bridge carries a metallic finger, which keeps the wire close to the top of such bridge, while the remainder of the wire is made to vibrate.

8thly. The vibrations of the wire are produced by touching it with a piece of cork with the same elastic force, and always at the distance of one inch from the immoveable bridge.

In Mr. Atwood's apparatus, the string hangs ver-

tically, its tension being regulated by a weight suspended at its lower extremity, a little below the place where the string comes in contact with a fixed pulley; the length of the string is terminated at top by a horizontal edge: the other point of termination, which, in the common monochords, as well as in many musical instruments, and in the Stanhope monochord, is a bridge over which the string is stretched, is in this construction effected by two steel edges vertically placed, that are capable of approaching, or of receding from one another, like the cheeks of a vice; these, being fixed on a frame worked by micrometer screws, can be easily moved in a vertical direction, so as to alter the length of the string in any desired proportion: these edges are separated occasionally by a spring, in order to let the string pass freely through, when its length is altered, and are closed again so as to press the strings lightly when that length is properly adjusted.

By means of this construction, the alteration of the tending force, by the application of bridges, &c. is wholly avoided.

The scale placed under the string of this monochord is divided into 100 equal parts, and each of these by a micrometer screw into 1000 equal parts; so that, by the aid of a microscope, and a proper index, the length of a given part of the string may be adjusted on the monochord true to the $\frac{1}{100000}$th part of its whole length.

It will be seen that the Stanhope monochord, though very ingeniously constructed, is, in some respects, inferior to the monochord contrived by Mr. Atwood.

The Rainbow.

Light, which embellishes with so much magnificence a pure and serene sky, by means of the innumerable stars that are spread over it, sometimes, in a dark and cloudy sky, exhibits an ornament, that

by the pomp, splendour, and variety of its colours, seems to attract the attention of every eye that has an opportunity of beholding it. In this short description, the reader will readily recognise the rainbow. We know this phenomenon never takes place but when a cloud opposed to the sun dissolves in rain; from which it follows, that, to observe this spectacle, the back of the spectator must be turned towards the sun. There is, likewise, though not always distinctly visible, a secondary, or much fainter rainbow, investing the former at some distance. This beautiful phenomenon has engaged the attention of persons in all ages, but the cause of it could not be ascertained till the discoveries concerning the division of the rays of light into their primary colours were made.

The doctrine of the different refrangibility of light enables us to give a reason for the size of a bow of each particular colour. The following are the facts upon which the phenomena depend.

1st. When the rays of the sun fall upon a drop of rain, and enter into it, some of them, after one reflection and two refractions, may come to the eye of the spectator, who has his back turned towards the sun, and his face towards the rain. Of the rays reflected from a drop of rain coming to the eye, those are called effectual which can excite a sensation; and they will not be effectual, when they come out of a drop of rain, unless they are parallel and contiguous.

When the sun shines upon the drops of rain as they are falling, the rays that come from those drops to the eye of the spectator, after one reflexion and two refractions, produce the primary rainbow, which is never larger than a semi-circle.

When the sun shines upon the drops of rain as they are falling, the rays that come from these drops to the eye of the spectator, after two reflexions and two refractions, produce the secondary rainbow. The colours of the secondary rainbow are fainter than those of the primary rainbow, and are ranged

in contrary order; for the primary rainbow is produced by such rays as have been only once reflected, the secondary rainbow is produced by such rays as have been twice reflected. But at every reflection some rays pass out of the drop of rain without being reflected, so that the more frequently the rays are reflected, the fewer of them are left to excite a sensation in the eye; therefore, the colours of the secondary bow are produced by fewer rays, and, consequently, will be fainter than the colours of the primary bow.

In the primary bow, reckoning from the outside, the colours are ranged in the following order: red, orange, yellow, green, blue, indigo, violet. But in the secondary bow, reckoning from the outside, the colours are reversed, and are ranged: violet, indigo, blue, green, yellow, orange, and red. So that the red, which is the outermost, or highest colour in the primary bow, is the innermost, or lowest colour in the secondary one. If the space occupied by all the coloured rays be divided into 360 equal parts, the red will occupy 45 of them, the orange 27, the yellow 48, the green 60, the blue 60, the indigo 40, and the violet 80, as shewn by the diagram, *Fig.* 31.

An experiment representing the phenomenon of the rainbow, consists in suspending a glass globe, filled with water, in a situation in which it is exposed to the sun, and moving it up and down in such a manner that the angles formed by the incident and emergent rays vary from 40° to about 51°. And in this globe the colours are observed to paint themselves successively in the order in which they present themselves in the globules of rain.

From the explanation thus given of the rainbow, it is easy to account for several effects, which are so many copies, as it were, of this magnificent picture. We succeed in the artificial imitation of it, by throwing water into the air, so as to scatter it, turning our back to the sun. We often perceive its colours in a *jet d'eau*; sometimes it is painted on the grass when wet with dew, and sometimes it

mixes its tints with the flowers that embellish the fields.

A lunar bow will be formed by rays from the moon, effected by drops of rain; but as its light is very faint in comparison with that of the sun, such a bow will very seldom be seen, and the colours of it, when seen, very faint and dim.

Pleasing Optical Appearances.

1. If a soap-bubble be blown up, and set under a glass, so that the motion of the air may not affect it, as the water glides down the sides, and the top grows thinner, several colours will successively appear at the top, and spread themselves from thence in rings down the sides of the bubble, till they vanish in the same order in which they appeared. At length a black spot appears at the top, and spreads till the bubble bursts.

2. If a piece of plain polished glass be placed upon the object-glass of a telescope, and the interval between them be filled up with water, as the glasses are pressed together, the same colours arise at the point of contact, and spread themselves in circular rings round that point in the same order as in the soap-bubble.

3. A convex and concave lens, of nearly the same curvature, being pressed closely together, exhibit rings of colours about the points where they touch. Between the colours there are dark rings, and, when the glasses are very much compressed, the central spot is dark.

4. Two pieces of plate glass, wiped clean, and rubbed together, will soon adhere with considerable force, and exhibit various changes of colours.

To render visible the opposite Currents in which Fluids are thrown, while they change their Temperature.

Fill a common eight-ounce phial, or cylindrical glass jar, about two inches or more in diameter, and

five or six inches long, with cold water, and diffuse through it a small portion of pulverised amber: let the phial of water be immersed into a tumbler, containing hot water: this being done, two currents, going in different directions, will be observed in the inner vessel, the one ascending, the other descending; that is to say, the minute particles of amber, which were diffused through the fluid, and were at rest before the heat was applied to the water in the inner vessel, will be seen in motion; those particles that are situated towards the sides of the glass, or which are nearest to the source of heat, will move upwards, whilst those that are in the centre move downwards; and thus two distinct currents are formed in opposite directions. These currents gradually diminish in velocity; and, when the water in the inner vessel has acquired the same temperature as that in the outer one, the particles of amber will again be brought to a state of rest.

If the position of the two glass vessels be reversed, namely, if the glass containing hot water be immersed in a vessel containing cold water, the motion of the currents will be also reversed: the particles next to the sides of the glass are thrown into currents, directed downwards, whilst the particles in the centre form a current upwards. The equilibrium of these two currents will also be restored, when the equalization of temperature of the water within, and that without, has been effected.

To render the experiment more decisive, the lower part of the water may be coloured by tincture of cabbage, or red ink, leaving the upper part uncoloured. If heat be then applied to the bottom part of the glass, the coloured part of the water gradually ascends, and uniformly tinges the whole fluid.

To change a Pack of Cards into various Pictures.

Take a pack of cards, and paint upon the white *side of* half the pack, any kind of figures, as men,

women, birds, flowers, &c.; then paint the other half of the cards, on that side on which the spots are, in the same way as the other half; so, between them both, you will have a complete pack of all pictures; and when you perform this trick, you must shew the cards but half way.

To let Twenty Persons draw Twenty Cards, and to make each draw the same.

Let any person draw a card from a pack, and put it in the pack again, but where you know where to find it again; shuffle the cards, as before directed; then let another person draw a card, and be sure he takes the same the other did; proceed in the same way with all the persons but the last, who is to draw another card, which also return to the pack, and shuffle till you have brought both the cards together. Then, shewing the last card to the company, the other will shew the trick.

To name several Cards which Two Persons have drawn from a Pack.

Divide a piquet pack into two parts by a long card; let the first part contain a quint to a king in clubs and spades, the four eights, the ten of diamonds, and ten of hearts, and let the other part contain the two quart majors in hearts and diamonds, the four sevens and the four nines. The cards may be divided in any other way that is easy to be remembered.

Then shuffle the cards, but be careful not to displace any of those cards of the last part which are under the long card: you then cut at that card, and leave the pack in two parts; next, present the first of these parts to a person, and tell him to draw two or three cards, and place the remainder on the table; you present the second parcel in like manner to

another, then having dexterously placed the cards drawn by the first person in the second parcel, and those drawn by the second person in the first parcel, you shuffle the cards, observing not to displace any but the upper cards: then spreading the cards on the table, you name those that each person drew, which you may very easily do, by observing the cards that are changed in each parcel.

To make a Card jump out of the Pack, and run on the Table.

Take a pack of cards and let any one draw any card they please; put it into the pack, so that you may know where to find it at pleasure. Put a small piece of wax under your thumb-nail, to which fasten a hair, and the other end of the hair to the card; spread the cards open on the table, and desire the one chosen to jump out, which you may readily cause it to do by means of the hair.

How to tell a Person any Card he thinks of, and to convey it into a Nut.

Take a nut, in which burn a hole with a hot bodkin, and with a needle break and extract the kernel. Write the name of a card on a piece of thin paper, and roll it up hard, and put it in the nut, stop the hole with wax, which rub over with a little dust that the puncture may not be perceived, then let some one draw a card; you must take care it be that which is written on the paper; desire him to break the nut, in which he will find the name of the card he has drawn.

To shuffle Cards in such a manner, as always to keep one certain Card at the Bottom.

In shuffling, let the bottom card be always a little *before*, or, which is best, a little behind all the rest

of the cards; put it a little beyond the rest before, right over your fore finger, or else, which is the best, a little behind the rest, so that the little finger of the left hand may slip up and meet with it; at the first, shuffle as thick as you can; and, at last, throw upon the board the bottom card, with as many more as you would preserve for any purpose, a little before or a little behind the rest; and be sure to let your fore finger, if the pack be laid before, or your little finger, if the pack be laid behind, always creep up to meet with the bottom card; and when you feel it, you may there hold till you have shuffled over again; which being done, the card which was first at the bottom will come there again: having perfected yourself in this manner of shuffling, you may accomplish any thing you please with packs of ten, twelve, or twenty cards, always leaving it at the bottom, however frequently you may shuffle them.

Hydromatic Temple.

The following is an account of a very elegant optical toy, or hydromatic temple. See *Fig.* 30.

Let us suppose two vessels, the uppermost filled with water, and sustained by two little pillars, one of which is hollow, and furnished with a cock, *e*. Let the other vessel be divided by a partition into two parts; the lower of which may be opened, or closed, by means of a cock at *d*.

Upon the partition place an image, *a*, which the spectator at *f*, cannot see, by a direct ray *f*, *g*. If now the cock, *e*, be opened, the water descending into the cavity, beneath the ray, will be refracted from the perpendicular; so that the spectator will now see the object by the refracted ray. And again shutting the cock, *e*, and opening the other, *d*, the water will descend into the lower cavity; whence the refraction ceasing, no rays will now come from the object to the eye; but by shutting the cock, *d*,

again, and opening the other, *e*, the water will fill the cavity again, and bring the object in sight afresh.

Artificial Halos.

The coloured rings, or halos, which are often seen surrounding the moon and sun, are occasioned by very thin vapour diffused through the atmosphere. They are supposed chiefly to encircle the moon; but, in this climate, hardly a day passes with light fleckered clouds, when, at least, portions of halos may not be perceived near the sun. It is only necessary to remove the glare of light which makes the delicate colours appear white. Thus, if we examine the reflexion from a smooth surface of water, we shall perceive that the sun gilds the fleecy clouds with segments of beautiful coloured rings. This effect is still more distinctly seen, if the rays from a hazy or mottled sky be received upon a sheet of white paper, held before a small hole in the window-shutter of a dark room. But even when the sun shines from an azure firmament, circles of the richest tints may be produced by experiment. Holding a hot poker below, and a little before the small hole in the shutter, throw a few drops of water upon, and the sun will be painted on the paper like the glowing radiations of the passion flower. The appearance is exactly similar to what the traveller, in awakening from a short slumber, perceives in a winter's morning, on opening his wearied eyes to a burning candle, concentric rings of violet, green, yellow, and red.

Beautiful Experiment.

It is easy to imitate and examine a most remarkable optical deception of horizontal refraction, by means of a square parallelopiped composed of plate glass. Having filled the half of this with cold water, let hot water be gently poured over it, and the cover placed upon the top. On standing a few feet *behind* the parallelopiped, and looking at distant

objects through the stratum where the hot and cold water have become blended, the double and inverted images will for a short time be clearly perceived. But a more durable effect is obtained, by filling one-third of the glass case, as represented in *Fig.* 32, with syrup, or a strong solution of white sugar, another third with distilled water, and the rest with pure alcahol. A mutual penetration slowly takes place between the conterminous surfaces of the alcohol A, and the water B, and between this and the syrup C, and after the lapse of perhaps two or three days, the blending spaces become sufficiently broad for observation. The appearances then are such as those exhibited.

Phosphoric Tapers.

Take a glass tube about four inches long, and one or two lines in the bore, closed at one end; introduce into it a few grains of phosphorus, previously dried on blotting paper. When this has been done, put a small taper, the extremity of which has been deprived of wax, into the tube, taking care that the end of the taper freed from the wax touches the phosphorus. Then seal the open end of the tube hermetically, and plunge the extremity into hot water, which will cause the phosphorus to melt and affix itself to the cotton of the wax taper. A line may then be drawn, by means of a diamond, or file, at one end of the tube. To use these tapers, the tube must be broken at the marked line; and, when the taper is drawn out, it takes fire and burns rapidly.

To imitate the luminous Appearance of the Lunar Disc.

Introduce a few pieces of phosphorus of the size of a pea, into a hollow glass ball of three or four inches in diameter, and having heated it to cause the phosphorus to catch fire, keep turning the ball

round, till half the inner surface is covered with phosphorus. When the inflammation has ceased, there will be left a whitish crust or lining, which in a dark place shines for some considerable time. Broad spaces will assume by degress an obscure aspect, while circular spots frequently interspersed, will yet glow with a vivid lustre.

Phosphorescence produced by Heat.

Take coarsely pulverized fluor spar; sprinkle it, in darkness, on the surface of a fire-shovel heated below redness; it will shine with a beautiful phosphorescent light, and the shovel will appear, for a few seconds, as if sprinkled over with gems. To exhibit the luminous property of fluor spar in the greatest perfection, let some oil be heated in a Florence flask till it nearly boils, and drop into it, gradually, pulverized fluor spar; the moment the latter touches the hot oil, a bright flash of light is emitted, which may be renewed by a fresh admixture of fluor spar, and by shaking the vessel. The variety of fluor spar, which is of a purple blue colour, and which, when scraped or struck, emits a fetid bituminous odour, is more phosphorescent by heat than any other variety of this mineral.

The Portable Diorama.

The ingenious and beautiful invention of the Portable Diorama is a most instructive and delightful production of art, capable of affording endless and refined amusement to all ranks and ages. A neat box contains a series of transparent views, abbey ruins, sea-pieces, various landscapes, &c., which fit into a slight wooden frame. There is also a number of atmospheric and other effects produced by having similar transparencies painted in clouds, with a rainbow, with a moon, or merely plain pieces of silk, of crimson, yellow, &c.; any of which, being placed *behind* the first-mentioned views, (and occasionally

combined with a moveable gauze curtain,) impart to them all the changes of morning, evening, dawn, sunset, moonlight, &c. &c., and gratify the spectator with the most charming and picturesque changes. Objects seem to take novel positions, and the entire scenes have all their relations varied from tempest to profound repose. It is really difficult to imagine, without seeing them, how materials so unimposing in their forms should be made to convey so much gratification to the mind.

Coral Islands.

The coral-making animals do not commence their labours at the extreme depth of the ocean, but on rocky shoals, the summits of sub-marine mountains, round which they form a united chain, irregular in shape, but generally approaching more or less to a circle. The outer ledge of the reef exposed to the surf of the sea is the first that shews itself above water; in process of time it becomes indurated, breaks, and crumbles by the action of the sea, and at length forms a barrier, within the sloping sides of which the living animals are seen carrying on their operations. Those observed by Chamiso, (the naturalist with Lieut. Kotzebue,) were the tubipora musica, millepora, cœlurea, obstichopora, and various kinds of polypi. As soon as the ledge has reached such a height that it remains almost dry at low-water, the coral insects leave off building any higher.

Coral reefs rise almost perpendicularly on the windward side, sometimes from the depth of 200 fathoms.

Steam-Gun Experiments.

At length this formidable weapon, destined, if ultimately adopted, to change the whole system of modern warfare, has been so perfected by Mr. Perkins, that the effects of its projectile power, from a musket bore, and with a lead ball of the usual

weight, may be fully judged. A trial was lately made at Mr. Perkins's manufactory in the Regent's Park, before the Duke of Wellington and Staff, together with the field officers of the engineers and artillery from Woolwich, most competent to judge from their scientific knowledge. Some preparatory experiments having been made, about the hour of nine, *a. m.*, Mr. Perkins commenced his discharges separately, but at short intervals, against an iron target, at the distance of thirty-five yards, being the utmost length the court-yard of the manufactory would admit. The bullets were rendered perfectly flat with the lowest pressure employed; and, on increasing it, they were shivered to small pieces. Twelve one-inch deal planks, framed in grooves an inch apart, were then opposed to the gun, at the same distance, and the ball passed through eleven of them. It was also discharged at a block of wood, against which the utmost force of gunpowder had projected bullets, and it was found equal to all that gunpowder could do. Musket-balls were also sent through an iron plate one-fourth of an inch thick, on which the utmost force of gunpowder had been tried, while that of the steam was not half so high as it was possible to carry it. The pressure used was about 900 lbs. to the square inch, or 65 atmospheres, while it might be carried as high as 200 atmospheres with perfect safety. Hitherto, steam has shewn its equality with gunpowder in force, and at 100 times less expense. For example, it would require 250 musket-discharges to project the same number of balls as the steam-gun at a slow rate, say 250 discharges per minute, or 15,000 per hour, which would demand 15,000 charges of powder every hour. The steam-gun would do this with five bushels of coals. The difference of cost of 15,000 charges of powder and five bushels of coals is easily calculated. It next became needful to shew wherein this terrible weapon of destruction left all that gunpowder would do far beyond competition. To discharge single balls, a hopper had

been filled with them, and they were dropped, one by one, into a barrel at the breech, as quick as the hand could move a small winch. This winch, with its valve, was now unscrewed, and the barrel communicated with the steam through an apparatus resembling the nave of a wheel, into which it was screwed. A tube, projecting like a single spoke, was screwed into this nave, (numerous radii of the same kind were shewn in a model applied to one nave, so that in one revolution each would stand in turn perpendicularly over the gun:) close to the gun it had a valve, above which were fifty-two musket-balls, and a screw closing the orifice of the tube at the top. This tube being perpendicular, the bullets, on opening the valve, fell into the gun by their own gravity, and were projected, one by one, at intervals barely perceptible to the senses, at the rate of 1000 per minute. The roar of the discharge resembled that of the loudest thunder; and the contents of one tube discharged in three or four seconds, afforded the most awful evidence of the power of this "mighty fluid" that imagination can conceive. After a discharge or two of this kind, at the target, in which the balls were shivered to atoms, and the ground strewed with their fragments, a plank of deal, about two feet wide, placed horizontally against a brick wall, was fired at, giving the gun a trifling lateral motion at the same time. The bullets perforated the board from end to end, regularly, at a few inches only apart from each other, and with astonishing regularity, the gun being capable of motion, like the pipe of a fire engine, in any direction. Thus, one musket-bore barrel would, in a second or two, annihilate a company of infantry opposed to it in line, and discharge nearly three times as many balls at once, as a company of ninety men could do with muskets previously loaded:—to re-charge their pieces before such a weapon, would be impossible. What, then, could not fifty such guns effect; the astonishing precision with which the balls are projected, each

hitting within an inch of its predecessor, was exemplified by a discharge against a brick wall, 18 inches thick. One discharge literally dug out a hole nearly a foot in diameter, half through its entire thickness, and this with common lead balls only: iron ones would have gone through it. A laudable anxiety has been displayed by government to avail itself of this tremendous application of steam, and we may now rest assured it will not be lost. Ten steam cannon in a field of battle would be more than equal to 200 on the present system, and a vessel of only six guns would be rendered more than a match for a 74. Of 500 balls fired every minute from one of these guns, if only one out of twenty were to reach the mark, ten of such guns would destroy 150,000 men daily. Unfortunately, it requires something more than individual property to try the discovery on a large scale. Mr. Perkins should be employed to direct other experiments, and perfect his invention upon the public account, for it is easy to see that this use of steam is yet but in its infancy, giant as it is: and that the expenses of enlarged experiments are more than private property can be expected to sacrifice.

The adoption of the most destructive implements possible in war, will be most friendly to humanity, by shortening its duration. Offensive war will profit much less than defensive. A fort may be made impregnable against an attacking force: and a breach (could such a thing be made under the fire of steam artillery,) could not be stormed. It is impossible to foresee what changes this discovery may not effect in the history of nations.

Production of Ice.

A chemist at Caen has discovered a very convenient method of obtaining ice at every season. It consists in mixing, in a small cask, five pounds of sulphate of soda pulverized, with four pounds of

sulphuric acid, at 36 degrees. The composition is capable of quickly freezing water. This freezing would inevitably take place at once, if large quantities were used; but in cases in which only such quantities as those above-mentioned are employed, the vessels necessarily parting with a large portion of their caloric to the bodies which they contain, the mixture must be made three times before the production of ice can be insured.

Improved Galvanic Battery.

A considerable improvement in the mode of forming the troughs of a galvanic battery has been made by Mr. Hart, of Glasgow; in order to illustrate which, it will be desirable to notice the preceding improvements of this interesting and powerful apparatus.

The substitution of the galvanic trough, instead of the pile of Volta, we owe to Mr. Cruikshanks, of Woolwich; but the exciting liquid causes a trough, made of wood, to warp, which cracks the cement, by which the plates are fixed, and the liquid insinuates itself into the fissures so as to destroy the insulation, and the repair of this defect is troublesome. In the Children battery, porcelain troughs were employed instead of wooden one's; these, however, are expensive, and from the affinity of the glazing, for acidulated moisture, it is difficult to keep the upper edges so dry as to render the insulation perfect. Dr Wollaston's ingenious improvement added to the power of the battery, yet did not remove the defect we have noticed. But Mr. Hart, after seeing the improvement made by Dr. Wollaston, who introduced a counterpart of copper to each plate of zinc, determined to add sides and bottoms to the double copper plates, so that they might form cells of themselves for the acidulated liquid; and copper, he found by experience, was only partially acted upon by the exciting

liquid; therefore this arrangement enabled him to dispense with the use of troughs.

In a battery constructed in this manner, the power, measured by the amount of gas evolved from the decomposition of water, was found considerably superior to that of one on the construction proposed by Dr. Wollaston; and the augmentation of power Mr. Hart attributes entirely to the insulation being more perfect in his arrangement.

Experiments in Optics.

Dr. Brewster, on the Powers of the Eye.

If we look on a narrow slip of white paper placed upon a black or a coloured ground, it will never appear to vanish, however long and attentively we view it. But if the eye be fixed steadily upon any object within two or three inches of the paper, so as to see it only *indirectly*, or by oblique vision, the slip of paper will occasionally disappear, as if it had been removed entirely from the ground, the colour of the ground extending itself over the part of the retina occupied by the image of the slip of paper. If the object seen indirectly be a *black* stripe on a white ground, it vanishes in a similar manner; and, what is still more remarkable, the same phenomena of disappearance take place whether the object be viewed with one or with both eyes. When the indirect object is luminous, like a candle, it never vanishes entirely, unless it be placed at a great distance; but it swells and contracts, and is surrounded by a halo of nebulous light, so that the excitement must extend itself to contiguous portions of the retina, which are not influenced by the light itself. If we place two candles at the distance of about eight or ten feet from the eye, and about twelve inches from each other, and view the one directly, and the other indirectly, the indirect image will be encircled with a bright ring of yellow light, and the bright light *within* the ring will have a pale blue colour. If

the candle be viewed through a prism, the red and green lights of the indirect image vanish, and leave only a large mass of yellow, terminated by a portion of blue light. While performing this experiment, and looking steadily and directly at one of the prismatic images of the candle, Dr. Brewster was surprised to observe that the red and green rays began to disappear, leaving only yellow and a small portion of blue: and when the eye was kept immoveably fixed on the same part of the image, the yellow light became almost pure white, so that the prismatic image was converted into an elongated image of white light. If the slip of white paper, viewed indirectly with both eyes, be placed so near as to be seen double, the rays which proceed from it no longer fall on corresponding points of the retina. In this case, the two images do not vanish simultaneously, but when the one begins to disappear the other begins soon after it, so that they sometimes appear to be invisible at the same time. In order to ascertain whether or not the accidental colour of an object seen indirectly would remain after the object had disappeared, Dr. Brewster placed a rectangular piece of red wafer upon a white ground, and having looked steadily at an object in its vicinity, the wafer disappeared; and though the accidental colour shewed itself just before the wafer had vanished, yet no trace of colour was visible afterwards.

The insensibility of the retina to indirect impressions has a singular counterpart in its insensibility to the direct impression of attenuated light. When the eye is steadily directed to objects illuminated by a feeble gleam or light, it is thrown into a condition nearly as painful as that which arises from an excess of splendour. A sort of remission takes place in the conveyance of the impressions along the nervous membrane: the object actually disappears, and the eye is agitated by the recurrence of excitements which are too feeble for the performance of its functions. If the eye had, under such a twilight,

been making unavailing efforts to read, or to examine a minute object, the pain which it suffers would admit of an easy explanation; but, in the present case, it is the passive recipient of attenuated light; and the uneasiness which it experiences can arise only from the recurring failures in the retina to transmit its impressions to the optic nerve. The preceding facts respecting the affections of the retina, while they throw considerable light on the functions of that membrane, may serve to explain some of those phenomena of the evanescence and re-appearance of objects, and of the change of shape of inanimate objects, which have been ascribed by the vulgar, to supernatural causes, and, by philosophers, to the acting of imagination. If, in a dark night, for example, we unexpectedly obtain a glimpse of any object, either in motion or at rest, we are naturally anxious to ascertain what it is, and our curiosity calls forth all our powers of vision. This anxiety, however, serves only to baffle us in all our attempts. Excited only by a feeble illumination, the retina is not capable of affording a permanent sight of the object, and, while we are straining our eyes to discover its nature, the object will entirely disappear, and will afterwards appear and disappear alternately. The same phenomenon may be observed in day-light by the sportsman, when he endeavours to mark, upon the unvarying heath, the particular spot where moor game has alighted. Availing himself of the slightest difference of tint in the adjacent heath, he keeps his eye steadily fixed upon it as he advances; but, whenever the contrast of illumination is feeble, he uniformly loses sight of his mark; and, if the retina is capable of again taking it up, it is only to lose it again. Dr. Brewster concludes his interesting paper by an explanation of the phenomenon observed by Messrs. Herschel and South, and shews that an expansion of the image accompanies indirect vision, and, therefore, a luminous point, seen indirectly, spreads into a disc *and* acts upon a greater portion of the retina: and,

he remarks, that the eye cannot correctly distinguish the colours of luminous points seen indirectly. And, he adds, if the explanation of the phenomena be the correct one, the astronomer may, by direct vision, obtain a view of faint stars by re-adjusting his eye.

Solar Phosphorus.

This name is given to various substances, which, when exposed to light, combine with it, and emit it again in the dark. Solar phosphori shine without any appreciable production of heat. The best substance of this kind is known by the name of *Canton's Phosphorus*. To prepare this substance, calcine oyster-shells in the open fire for half an hour, select the whitest and largest pieces, and mix them with flowers of sulphur, in the proportion of one part of the latter to three parts of the former, pack the whole closely into a crucible, put on a cover, and heat it pretty strongly for one hour; when the crucible has again become quite cold, turn out its contents and select the whitest pieces for use.

The quantity of light which an eight-ounce bottle full of it gives, when brought into a dark room, after having been exposed for a few minutes to the sun, or day-light, is sufficient to shew the hour by a watch, if the eyes have been previously kept shut a minute or two.

Another preparation of this kind, which is known by the name of *Wilson's Phosphorus*, is thus prepared: Select oyster-shells, the thicker they are the better; then take most of the flaming coals, but not all of them, off a charcoal fire which is burning briskly, strew the shells over the surface, and replace the coals that have been taken off. In about an hour's time, take out the calcined shells, observing to break them as little as possible; and, after exposing them for a few minutes to the light, they will be found to have acquired a high degree of phosphorescence, glowing in the dark in a very beautiful

manner with most of the prismatic colours. It is not, however, absolutely necessary that the shells should be calcined in the open fire; for, if they are heated sufficiently in a close crucible, they will exhibit prismatic colours, chiefly blue and green, though not so bright as by the former method. If the calcination is effected in an iron crucible, all those parts of the shells that are in contact with the sides of the crucible will glow with a red light. The contact of inflammable matter, and particularly charcoal, with the shells during their calcination, appears to contribute eminently to the brilliancy of the phosphorus: hence it is, that if shells are calcined in a crucible in contact with thin plates of steel, the phosphorus thus produced will be much brighter, and of more various colours, than when plates of iron are employed; and, on the other hand, if flat pieces of charcoal are made use of, the intensity of the colours, especially the blue, green, and red, is far greater than in those produced by steel.

To kindle Spirit of Wine without contact of Fire.

Pour four or six drachms of spirit of wine into a tea-cup, and add to it ten or fifteen grains of chlorate of potash. If to this mixture about six drachms, by measure, of sulphuric acid be added, it begins to boil, a multitude of small fire-balls of a vivid blue colour dart out of the fluid, and the whole bursts into flame.

Compression.

In gases, expansion produces cold, and compression heat. A sudden compression of air produces heat enough to inflame tinder. Take a small tube, either of glass or metal, about three-eighths of an inch in diameter, and four inches long, securely stopped at *one* extremity. Fix a bit of dried fungus to the

end of the rammer, then thrust it smartly down the tube, and the heat of the compressed air therein contained will cause the fungus to ignite.

To make the Torricellian Experiment, or to prepare a Barometer.

Procure a glass tube about 33 inches long, with an aperture of about a quarter of an inch in diameter; pour mercury into it with a small paper funnel, till it is quite full, then place the finger hard upon the mouth of the tube, and invert it in a cup half filled with quicksilver. If this is dexterously performed, no air will remain in the tube, and it will be completely filled with quicksilver from the top to within three or four inches of the quicksilver in the cup; this will, however, depend on the state of the air at the time of the experiment. Should any air remain in the tube, the above operation of inverting the tube must be repeated till it is expelled. A tube prepared in this manner is a barometer in the simplest form; and if fastened to a frame with an attached scale, and a small box, containing mercury, instead of the cup, it will be the common barometer.

Illustration of the Formation of Water.

Fill a jar with oxygen gas, and fill also with hydrogen gas a bladder, furnished with a stop-cock, and with a long brass pipe like the letter S, and drawn out to a fine point. On pressing the bladder, a stream of gas will issue from the pipe, which may be set fire to, and brought cautiously under the inverted jar of oxygen gas. By this intercourse, the stream of hydrogen gas will be burnt in a confined portion of oxygen gas: by continuing the combustion a sufficient time, the water will rise gradually within the jar. On the first impression

of the heat, indeed, a small quantity of gas will escape from the jar, which will render it difficult to ascertain what degree of absorption actually takes place. But this loss may be prevented by using a jar with a neck at the top, to which a compressed bladder is firmly tied. The expanded air, instead of escaping through the water, will now enter the bladder at the top; and when the experiment is closed, and the vessels have cooled, it may be ascertained, by pressing out the gas from the bladder, what quantity of oxygen has been consumed.

By the slow but continued inflammation of hydrogen gas in common air, a sufficient quantity of water may be formed to satisfy any one with respect to its composition. This may be done in the following way:—Fill a bladder, furnished with a stop-cock and pipe, with hydrogen gas. Procure a large glass globe, having openings opposite to each other, then set fire to the stream of hydrogen gas passing from the tube, and introduce it into the centre of the globe. The combustion may be continued, if required, till all the inflammable air is burnt; and drops of water will be observed running down the inside of the globe.

Effect of Hot Water on Flowers.

The following fact is deserving of record, as an interesting addition to what has hitherto been discovered on the subject of vegetable physiology, and as enabling the lovers of flowers to prolong for a day the enjoyment of their short-lived beauty. Most flowers begin to fade after being kept twenty-four hours in water; a few may be revived by substituting fresh water; but all the most fugacious (such as the poppy, and perhaps one or two others excepted) may be completely restored by the use of hot water. For this purpose, place the flowers in scalding water, deep enough to cover about one-*third* of the length of the stem, and by the time

the water has become cold, the flowers will have become erect and fresh; then cut of the coddled ends, and put them into cold water.

Mode of Attracting Water.

Hang a quantity of wool, tied loosely together, down into a deep well, about five or six yards from the water; leave it in that position through the night, and its weight will, in the morning, be greater by one-fifth than it was the evening before. The additional weight will have been caused by the accession of particles of water from the humid atmosphere.

Illustration of the Art of Calico Printing.—To produce a Scarlet Pattern on a Black Ground.

Boil a piece of white muslin, or calico, for a few minutes, in a solution of acetate of iron, and dry it strongly near a fire. Having done this, rince it in water, and dye it black, by boiling it for a short time with a few chips of logwood and water; and, lastly, clear it of the superfluous dye, by rinsing it in water. Then suffer the dyed cloth to dry again, and sprinkle it over with lemon-juice, or dilute muriatic acid. It will then be seen, that, wherever the lemon-juice is applied, it will turn the dyed stuff of a scarlet colour; and in this manner any pattern may be produced upon a black ground, upon calico or linen cloth.

To produce White upon a Black Ground.

Boil a piece of white muslin for a few minutes in a solution of sulphate of iron, composed of one part of green sulphate of iron, and eight of water; squeeze it out and dry it. Then imprint upon it

spots, or any pattern you choose, with lemon-juice; render it dry again, and rinse it well in water. If the stuff now be boiled with logwood chips and water, it will exhibit white spots upon a black ground.

Experiment to shew the separation of Bodies by Weight.

Take a bottle with a long neck, and fill part of it with water; take a glass, and pour claret and water into it; reverse the bottle with the bottom upwards, stopping the mouth of it with your finger; then dip the mouth within the glass, and remove the finger: keep the bottle in that position for a time, and the wine will separate from the water, ascend and settle in the top of the bottle, and the water will descend from the bottle, and settle in the bottom of the glass; the passage will be apparent to the eye, for you will see the wine, as it were in a small vein, rising through the water.

Let the upper glass be wine and the lower water, there follows no motion at all; this separation of the wine and water appears to be made by weight, the water being made pensile, and a considerable weight of it in the belly of the bottle, supported by a small pillar of the same liquid in the neck of the bottle, it is this circumstance which sets the motion at work, for wine and water in a vessel will not separate by long standing.

To bleach Books and Copper-plate Prints, which have become discoloured by Age, Smoke, &c.

If a book, take off the binding, unsew the leaves, and separate then; place them in a shallow leaden vessel, with slips of common window glass interposed between them, so that the leaves or prints lie horizontally, without touching each other: or, a still better method is the following:—Make a wooden frame, of about the size of the leaves or prints to

be bleached, and having placed upon it the slips of glass, let the leaves or prints be placed on the glass perpendicularly, about a line distant from each other. This being done, pour into the vessel the bleaching liquid, which is made by dissolving one part by weight of oxmuriate of lime, in four parts of warm water, and suffer the articles to be immersed in it for twenty-four hours; they may then be rinsed in soft water. By this process the paper will acquire a whiteness superior to what it originally possessed. All ink spots, if any, will be removed; but oil or grease spots are not affected by it. Copper-plate prints bleach more easily than letter-press.

Cleaning of Engravings.

Put the engraving on a smooth board; cover it thinly with common salt, finely pounded; pour, or squeeze lemon-juice upon the salt, so as to dissolve a considerable portion of it; elevate one end of the board, so that it may form an angle of about forty-five or fifty degrees with the horizon. Pour on the engraving boiling water from a tea-kettle, until the salt and lemon-juice be all washed off; the engraving will then be perfectly clean and free from stains. It must be dried gradually on the board, or some smooth surface. If dried by the fire, or the sun, it will be tinged with a yellow colour.

To form a Lamp which floats on the Surface of the Oil which it consumes.

Take a piece of common writing paper, and cut it in the form of a circle, of about three-eighths of an inch in diameter; in the middle of which, make a small hole with a pin, and insert a small piece of soft cotton thread, raised nearly a quarter of an inch above the paper; this serves as the wick of the lamp, and, when lighted, has the effect of making

the whole move about on the surface of the oil, in a very curious manner.

To exhibit the Pressure of Fluids at different Depths.

The pressure of fluids at very great depths is finely illustrated by making a well corked empty bottle descend to a great depth, and then pulling it up again: however well corked it may be, the cork is always found in the inside, and the bottle full of water, when pulled up.

Experiment with a Red-hot Poker.

The effects commonly known by the appellations of mirage, and Fata Morgana, may be completely imitated, as Dr. Wollaston has shewn, by looking at a distant object along a red-hot poker, or through a saline or saccharine solution, with water and spirit of wine floating on it. *Fig.* 34 shews the appearance of a pin, and of the word POKER, when looking along the surface of a red-hot poker.

Magnetic Experiment.

The following easy experiment furnishes a numerous assemblage of little phenomena.

Put on a board a pinch of iron filings, and so place a magnet underneath the board, that its direction, if continued, would pass through the centre of the part strewed with filings. In proportion as you agitate the board by slight concussions, you will see the particles of filings disperse themselves on all sides, as if they were moved upon the radii of a circle, leaving void the spot they first occupied, and ranging themselves round it in the form of a disc.

Prismatic Spectrum.

The common optical instrument called a prism is a triangular piece of glass, through which, if a pencil of rays is made to pass, and thrown on a white wall or screen, an oblong spectrum is produced, which is variously coloured, and it consequently follows that some of the rays are more refrangible than others.

The spectrum thus formed is, perhaps, the most beautiful object which any of the experiments of philosophy present to our view. The lower part, which consists of the least refrangible rays, is of a lively red, which, higher up, by insensible gradations, becomes an orange; the orange, in the same manner, is succeeded by a yellow; the yellow by a green; the green by a blue; after which follows a deep blue or indigo; and, lastly, a faint violet.

The Prismatic Tetotum.

Cut out a circular piece of stout card-paper, on which paint the prismatic colours in the proper proportions, which, if the space occupied by the coloured ray be divided into 360 equal parts, the different colours will occupy the spaces as described at *Fig.* 31. Fix an ivory peg in this piece of card paper, like a common tetotum, and, causing it to turn round rapidly, it will be found that no particular colour can be perceived, but that a light greyish colour is produced.

Snow Spectacles

Are made of wood, or solid bone, properly formed to cover the organs of vision, and tied on behind the head. They have two slits the exact length of the eyes, but very narrow, and can be seen through, very distinctly, and without the least inconvenience. They were invented by the Esquimaux, who call them their "snow-eyes," the use of which preserves them from snow-blindness, a very dangerous and

painful malady, caused by the action of the light strongly reflected from the snow, especially in the spring, when the sun is considerably elevated above the horizon. The use of these eyes considerably strnegthens the sight, and the Esquimaux are so accustomed to them, that when they have a mind to view distant objects, they commonly use them instead of spy-glasses. Surely, a more ingenious device never originated among any untutored tribe.

Paradox.

How can twenty-four trees be planted, that there shall be twenty-eight rows, and four trees in each?

First, make a circle *Fig.* 33, which divide into eight equal parts, and inscribe two geometric squares, in each of which draw two diagonals; then draw the lines AB, AC, &c. from all the angles of both the squares; after which, draw the parallels, as per figure, and it will answer the conditions of the problem.

Artificial Memory.

To remember any thing in history, &c. a word is formed, the beginning whereof being the first syllable of the things sought, does, by frequent repetition, of course draw after it the latter part, which is so contrived as to give the answer: thus, in history, the deluge happened in the year before Christ 2348, and is signified by the technical word Del*etok*, *del* standing for deluge, and *etok* for the figures expressing the period, as hereafter shewn. The first thing, therefore, is to learn exactly the following series of vowels and consonants, which are to represent the numerical figures, so as to be able, at pleasure, to form a technical word, which shall stand for any number, or to resolve a word already formed, thus—

a	e	i	o	u	au	oi	ei	ou	y
1	2	3	4	5	6	7	8	9	0
b	d	t	f	l	s	p	k	n	z

Here, a and b stand for 1, e and d for 2, and so on.

These letters are assigned arbitrarily to the respective figures, and may very easily be remembered. The diphthong au being composed of a 1 and u 5 stands for 6; oi for 7, being composed of o 4 and i 3; ou for 9, being composed o 4 and u 5. The dipthong ei will easily be remembered for 8, being the initials of the word. In like manner, for the consonants, where the initials could conveniently be retained, they are made use of to signify the number, as t for 3, f for 4, s for 6, and n for 9, the rest were assigned without any particular reason. Thus, to remember the diameter of the orbit of the earth in English miles 172,102,795, the technical word for which will be dorbter *boid-aze-poul*; further let it be observed, that as z and y are made use of to signify the cypher, where many of them meet together, to avoid repetition, let g stand for hundred, th for thousand, and m for million; thus, ag will be 100, ig 300, ong 903, &c., ath 1000, oth 4000, &c.; for instance, solconter *esoklaum* is the technical word for the solid content of the earth 264,856,000,000 cubic miles.

In the application thereof to chronology, the ages of the world before our Saviour's time are generally divided into six; the first from the creation to the deluge, the second from the deluge to the call of Abraham, &c. according to the following periods:

	Before Christ.
The creation of the world	4004
The deluge	2348
The call of Abraham	1921
Exodus, or the departure of the Israelites for Egypt	1491
The building of Solomon's temple	1012
Cyrus, or the end of the captivity	536

All which is expressed thus:

Cre*otho*, Dele*tok*, Aba*neb*, Exa*fna*, Tem*bybe*, Cy*ruts*.

The Roman letters signify the first syllable of the remarkable word, as Cre for the creation, Del the

deluge; and those letters in italics represent the figures of the era, as set down in the table.

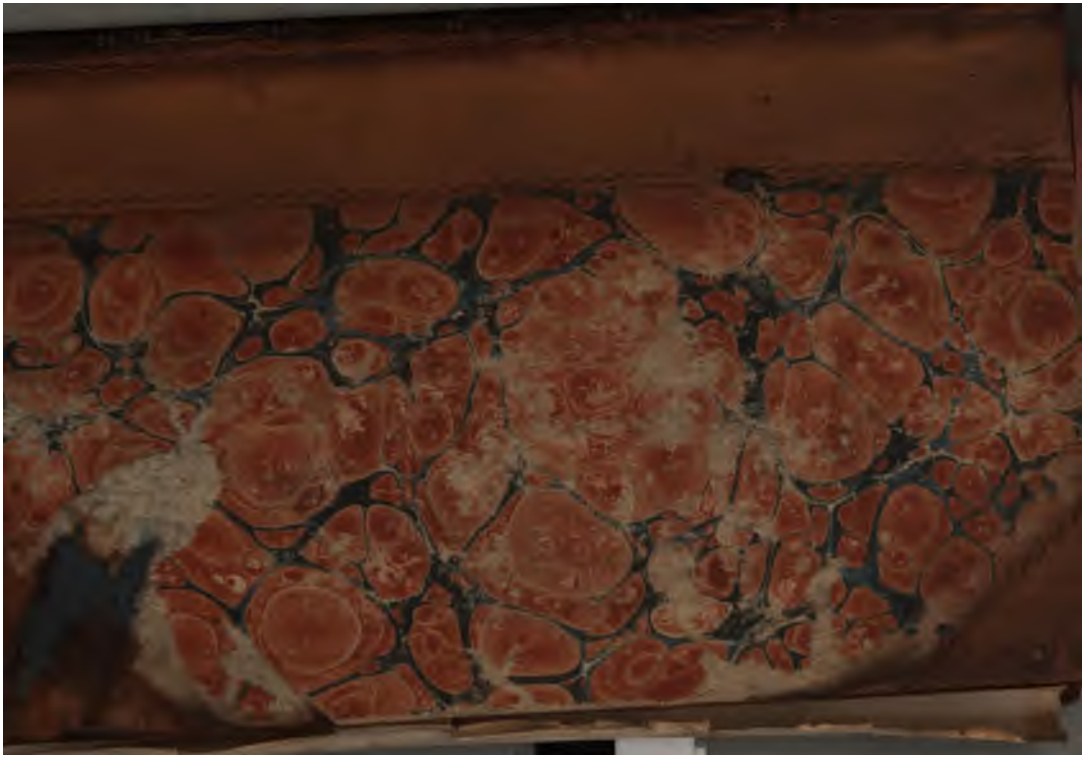
Again, the two following lines:

Nicsilcon-ari*tel*, Codathema*teib*. Epthcetheneș*fib*,
Challemar-endi*ola*, Covijust-O*lus*, Cageopo-mon-
seis.

These two lines are a short history of the first six general councils, and each syllable has its distinct signification.

The first represents the place where it was held; the second shews who was pope at that time; the third, under what emperor; the fourth, against what heretic; the fifth, in what year of our Lord; for instance, Nicsilconari*tel*, nic, denotes the council of Nice; sil, Pope Silvester; con, the Emperor Constantine; ari, the heretic Arius; and tel, the year 325. The second memorial word Codathema*teib*, co, denotes the council of Constantinople; da, Pope Damascus; the, the Emperor Theodosius; ma, the Macedonians, and teib, 381. The third, Ephcetheneș*fib*, Eph, the council of Ephesus; ce, Pope Celestine; the, the Emperor Theodosius; nes, the Nesterians; and fib, the year 431.

This will be sufficient to give the reader an idea of forming a key to assist the memory equal to the science of mnemonicks.

THE END.

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